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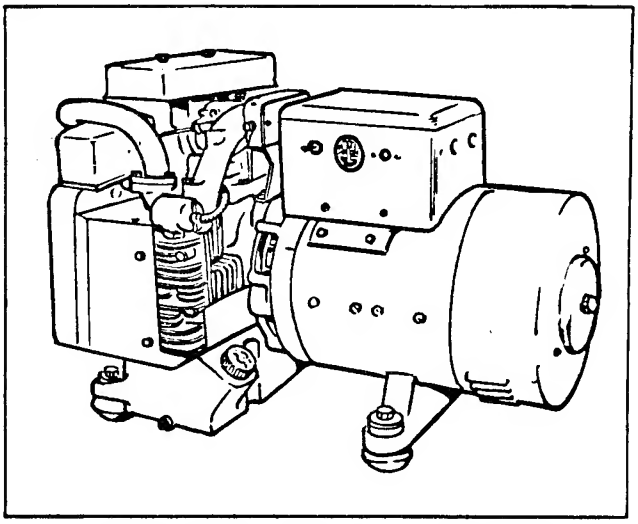
ONAN
ELECTRIC GENERATING PLANTS
CCKB
SERIES

927-503 11J65



TYPICAL MODEL CCKB

INTRODUCTION

This manual contains all the information necessary for properly servicing CCKB electric generating plants. Unless otherwise stated, these instructions apply to all standard plants of the CCKB Series. For installation, preparation and operating instructions, refer to Operator's Manual.

Electrical output characteristics of the plant appear on the nameplate, with the model designation and the serial numbers. The plant model and specification numbers are separated by a diagonal line (/). The plant specification consists of a *number* which indicates optional equipment as ordered by the purchaser; and of a *letter* at the end, which is advanced to coincide with production modification by the manufacturer. Reference to the nameplate Spec. letter may be necessary for the operator to select the instructions in this manual which apply to the model in question.

Some details of these instructions may not apply to special models having modifications specified by the purchaser. Due to the wide variety of uses for which these plants are suitable, these instructions must be of a general nature. However, by using the instructions and recommendations given in this manual as a general guide, it will be possible to properly maintain the plant.

Instructions for 60-cycle, 3,600-rpm plants apply also for 50-cycle, 3000-rpm plant except for current frequency and operating speed. Be sure appliances are adaptable to the current frequency of the plant.

The engine end is designated as the *front end* of the plant. *Left side* and *right side* of the plant are determined by viewing from the front end. Cylinder number one (nearest the timing gears) is on the *left side* of the plant.

DESCRIPTION

GENERAL

Each CCKB generating plant is a complete electric power plant, consisting of an internal combustion engine, and a self excited electric generator, directly connected to the engine. Controls and accessories suitable for a normal installation and according to the particular model are supplied.

The manual and portable type plants are designed for manual starting only, and cannot be connected to batteries for electric starting. The remote control type plant is designed for electric starting. When properly connected to a 12-volt battery, the plant may be started electrically at the plant, from one or more remote control switch points, or through automatic controls. The remote control type plant has a built in charging circuit for keeping the starting battery in a well charged condition.

Each generating plant is given an actual running test at the factory and is carefully checked under various electrical load conditions before shipment, to assure that it is free of any defect and that it meets all performance requirements.

ENGINE DETAILS

Type: Horizontal opposed 2-cylinder, 4-stroke cycle, L-head
Bore: 3-1/4"
Stroke: 3"
Displacement: 50 cubic inches
Horsepower: 19.5 B.H.P. at 3,600-rpm
Compression Ratio: 7 to 1
Cylinder and Crankcase: Integral, cast iron
Main Bearing: Precision – Sleeve Type
Bronze Faced
Camshaft Bearings: Sleeve type, babbit faced, steel backed
Pistons: 3-ring, aluminum alloy, full floating type piston pin
Connecting Rods: Forged steel, separate bearing
Lubrication: Pressure, gear driven, gear type oil pump
Cooling: Air, pressure flow
Fuel: Gasoline (gas optional)
Speed Control: Internal centrifugal flyball type governor, external adjustments...auxiliary speed booster
Ignition: Manual and portable plants – flywheel type magneto
Remote start plants – battery

Positive rotators are used on the valves which are stellite faced and seat on stellite replaceable seats. Valve tappets are adjustable, self locking.

GENERATOR DETAILS

The alternating current generator is a revolving armature, self excited, inherently regulated type. The inherent design of the generator with saturated, 2-pole, shunt wound field, assures close regulation of voltage between no load and full load conditions. A special series winding in the field of the remote starting models permits the generator to be used as a starting motor.

The armature is connected directly to the engine crankshaft through a taper fit and held in place by a stud which passes through the hollow center of the shaft. A large ball bearing supports the outer end of the armature. The armature contains both ac and dc windings, the ac windings connecting to the collector rings, the dc windings connecting to the commutator.

CONTROLS

Manual and Portable Type Plants: These plants are started by manually cranking with a pull rope. The carburetor is manually choked. The stop button is located on the plant blower housing. This type plant cannot be connected to batteries for electric starting.

Remote Control Plant: Plants are designed for electric starting, have an electric choke on the carburetor, a start-stop switch, a charge ammeter, and a switch for manual or electric start located on the control box over the generator. The controls are designed so that auxiliary automatic or load transfer control equipment may be connected.

ADJUSTMENTS

Generating plant satisfactory performance is dependent upon correct adjustments. However, adjustments cannot fully compensate for low engine power, neglect of periodic servicing, etc.

GOVERNOR

The governor controls the engine speed. Refer to the illustration Fig. 1-1.

Carefully study the related subjects in the following paragraphs and check each point in the order given before attempting adjustments on the governor.

Before making final governor adjustments, run the plant about 15-minutes under light load to reach normal operating temperature. (If the governor is completely out of adjustment, make a preliminary adjustment at no load to first attain a safe voltage operating range.)

Engine speed determines the output voltage and current frequency of the generator. By increasing the engine speed, generator voltage and frequency is increased, and by decreasing the engine speed, generator voltage and frequency is decreased. An accurate voltmeter or frequency meter (preferably both) should be connected to the generator output in order to correctly adjust the governor of the ac plant. A small speed drop not noticeable without instruments will result in an objectionable voltage drop. The engine speed

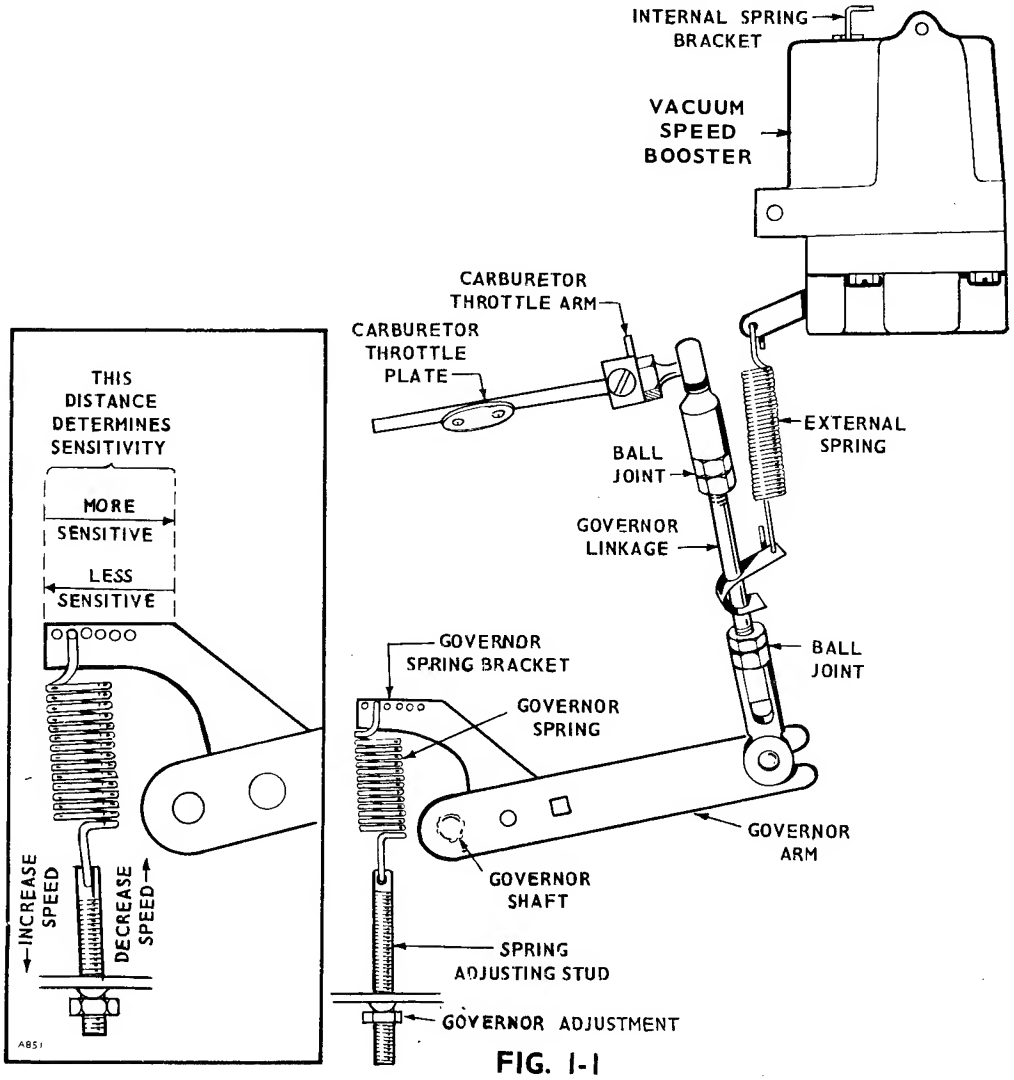


FIG. 1-1

can be checked with a tachometer.

The governor arm is fastened to a shaft which extends from the gear cover, and is connected by a ball joint and link to the carburetor throttle arm. Flyballs behind the cup on the camshaft gear, actuate the governor arm. If the carburetor has been removed, or the governor disassembled, it may be necessary to re-adjust the governor.

A binding in the bearings of the governor shaft, in the ball joint, or in the carburetor throttle assembly will cause erratic governor action or alternate increase and decrease in speed (hunting). A lean carburetor adjustment may also cause hunting. Springs of all kinds have a tendency to lose their calibrated tension through fatigue after long usage. If all governor and carburetor adjustments are properly made, and the governor action is still erratic, replacing the spring with a new one and resetting the adjustments will usually correct the trouble.

Steps to Follow: This gives the procedure only briefly. Refer to the details on each subject herein.

1. Adjust the carburetor main jet for the best fuel mixture while operating the plant with a full rated load connected.
2. Adjust the carburetor idle needle with no load connected.
3. Adjust the length of the governor linkage.
4. Check the governor linkage and throttle shaft for binding or excessive looseness.
5. Adjust the governor spring tension for rated speed at no load operation (booster temporarily disconnected).
6. Adjust the governor sensitivity.
7. Recheck the speed adjustment.
8. Set the carburetor throttle stop screw.
9. Adjust booster (where used).

Linkage: The engine starts at wide open throttle. The length of the linkage connecting the governor arm to the throttle shaft and lever is adjusted by rotating the ball joint. Adjust this length so that with the engine stopped and tension on the governor spring, the stop pin on the carburetor clears the throttle stop screw by 1/32" as illustrated in Fig. 1-3. This setting allows immediate control by the governor after starting. It also synchronizes the travel of the governor arm and the throttle shaft.

Speed Adjustment: With the warmed-up plant operating at no load, adjust the tension of the governor spring. Refer to the Voltage Chart and the Speed Chart. Turn the speed adjusting nut to obtain a voltage and speed reading within the limits shown.

Sensitivity Adjustment: Refer to the Governor Adjustment Fig. 1-1, and to the Voltage and Speed Charts. Check the voltage and speed, first with no load connected and again with a full load. Adjust the sensitivity so as to give the closest regulation (least speed and voltage difference between no load and full load) without causing a hunting condition.

To increase sensitivity (closer regulation), shift the adjusting clip toward the governor shaft. An adjustment for too much sensitivity will cause alternate increase and decrease of engine speed (hunting).

To decrease sensitivity, shift the adjusting clip toward the outer end of the governor arm. Too little sensitivity will result in too much difference in speed between no load and full load conditions.

Any change in the sensitivity adjustment usually requires a compensating speed (spring tension) adjustment.

SPEED-BOOSTER ADJUSTMENT

After satisfactory performance under various loads has been attained by governor adjustments without the booster, the booster can be connected. Connect the booster external spring to the bracket on the governor link (rod). With the

VOLTAGE CHART
FOR CHECKING GOVERNOR REGULATION

ALTERNATING CURRENT TYPES OF PLANTS NOTE: Output rating is at Unity power factor load.	120-V 1-Phase 2-Wire or 120/240-V 1-Phase 3-Wire	240-V 1-Phase 2-Wire	208-V 3-Phase 3-Wire
Maximum no load volts	126	252	218
Minimum full load volts	110	220	192
Maximum voltage drop from no load operation to full load operation	16	32	26
Preferred voltage regulation, no load to full load operation	118-114	236-228	205-211
Preferred voltage spread	4	8	6

SPEED CHART
FOR CHECKING GOVERNOR REGULATION

ALTERNATING CURRENT TYPES OF PLANT	FOR ALL 60-CYCLE PLANTS	FOR ALL 50-CYCLE PLANTS
Maximum no load speed		
RPM (revolutions per min.)	3,840	3,420
Cycles (current frequency)	64	57
Minimum full load speed w/o booster		
RPM (revolutions per min.)	3,420	3,000
Cycles (current frequency)	57	50
Maximum speed drop from no load operation to full load operation		
RPM (revolutions per min.)	180	180
Cycles (current frequency)	3	3
Preferred speed regulation, no load to full load operation		
RPM (revolutions per min.)	3,660-3,540	3,180-3,060
Cycles (current frequency)	61-59	53-51
Preferred speed spread		
RPM (revolutions per min.)	120	120
Cycles (current frequency)	2	2

plant operating at no load, slide the bracket on the governor link just to the position where there is no tension on the external spring.

Apply a full rated electrical load to the generator. The output voltage should stabilize at nearly the same reading for full load as for no load operation. The speed may remain about the same or increase when the load is applied, resulting in a frequency 1 or 2-cycles *higher than* the no load frequency. (1-cycle is equal to 60-rpm for a 2-pole generator). If the rise in frequency is more than 2-cycles, lessen the internal spring tension. If there is a drop in the frequency, increase the booster internal spring tension. To increase the tension, pull out on the spring bracket, and move the pin to a different hole.

With the booster disconnected, a maximum drop of 3-cycles from no load to full load is normal. With the booster in operation, a maximum *increase* of 2-cycles from no load to full load is normal. A drop of 1-cycle at 1/4 load is permissible, giving an over all spread of 3-cycles, maximum.

The effect of the booster is limited by the general condition of the engine. The booster cannot compensate for a loss in engine vacuum caused by leaky valves, worn piston rings, etc.

The booster requires little maintenance other than using a fine wire to clean the small hole in the short vacuum tube which fits into the hole in the top of the engine intake manifold. Do not enlarge this hole. If there is tension on the external spring, when the plant is operating at no load or light load, it may be due to improper adjustment, restricted hole in the small vacuum tube, or a leak in the booster diaphragm or gasket.

OIL PRESSURE RELIEF VALVE ADJUSTMENT

The oil pressure of the plant can be easily adjusted by means of the slotted stud and lock nut located just below the governor linkage, as illustrated. Oil pressure reading when the plant is thoroughly warmed up is from 25 to 40 lbs. To increase oil pressure, loosen the lock nut and turn the stud in. To decrease oil pressure, loosen the lock nut and turn the stud out. Be sure to tighten the lock nut securely after making an adjustment.

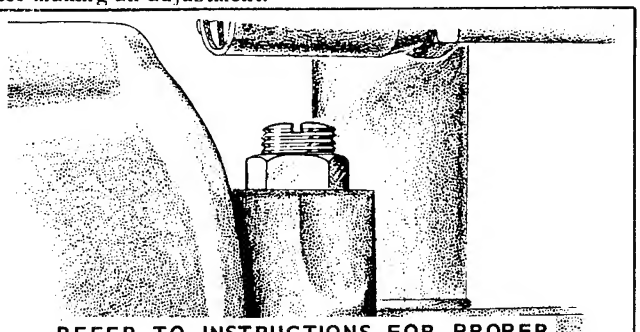


FIG. 1-2

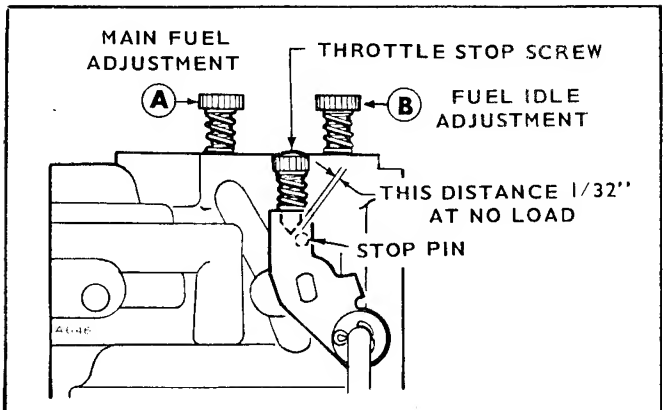


FIG. 1-3

Low oil pressure may point to worn or poorly fitted main or connecting rod bearings, a weak or broken by-pass spring, a defective gage or a poor adjustment. Check the oil pressure gage before making any other test, it may be defective.

GASOLINE CARBURETOR ADJUSTMENT

Adjusting the carburetor means obtaining the correct fuel-to-air mixture for smooth, efficient operation. The carburetor should be adjusted in two steps – first the idle adjustment and then the load adjustment (Fig. 1-3).

Important: *If the carburetor is completely out of adjustment so the engine will not run, open both needle valves 1 to 1-1/2 turns off their seats to permit starting. Do not force the needle valves against their seats. This will bend the needle.*

Before adjusting the carburetor, be sure the ignition system is working properly and the governor is adjusted. Then allow the engine to warm up.

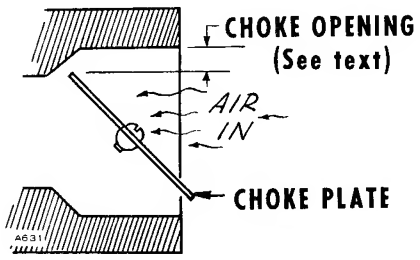
1. With no load on the generator, turn the idle adjustment out until the engine speed drops slightly below normal. Then turn the needle in until speed returns to normal.
2. Apply a full load to the generator.
3. Carefully turn the main adjustment in until speed drops slightly below normal. Then turn the needle out until speed returns to normal.

ALTERNATE METHOD, USE WHEN THERE IS NO LOAD ADJUSTMENT POSSIBLE

1. Start the plant and allow it to warm up.
2. Push in on the governor mechanism to slow the plant down to about 400 - 500-rpm.
3. Set the idle adjustment screw for even operation (so the engine is firing on both cylinders and running smoothly).
4. Release the governor mechanism to allow the engine to accelerate. If the engine accelerates evenly and without a lag. The main adjustment is correct. If not, adjust the needle outward about 1/2 turn and again slow down the engine and release the mechanism. Continue until the engine accelerates evenly and without a time lag after releasing the governor.

With the carburetor and governor adjusted, set the throttle

AMBIENT TEMP. (°F)	60	65	70	75	80	85	90	95	100
CHOKE OPENING (Inches)	1/8	9/64	5/32	11/64	3/16	13/64	7/32	15/64	1/4



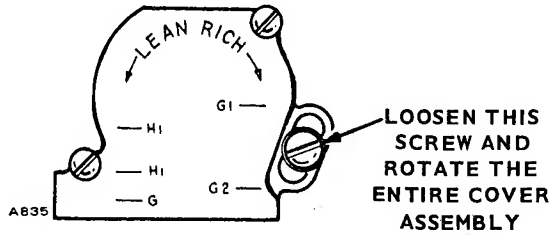


FIG. 1-4

stop screw, Fig. 1-3, to allow 1/32" clearance to the stop pin with the plant operating at no load. This prevents excessive hunting when a large load is suddenly removed.

GAS FUEL CARBURETOR ADJUSTMENTS

When operating on gas fuel, follow the procedure given for gasoline fuel, using gas fuel adjusting screws. Always be sure the carburetor choke is locked in its wide open position.

THERMO-MAGNETIC CHOKE

Remote control plants are equipped with an automatic choke. This choke uses a strip heating element and a heat sensitive bimetal spring to control the choke plate position. A solenoid, actuated during engine cranking, closes the choke all or part way depending on ambient temperature.

The bimetal is calibrated to position the choke to the proper opening under any ambient condition. The choke is adjusted at the factory. If, for any reason, readjustment is required, use the following procedure.

Adjustment must be made with the bimetal at ambient temperature. Do not attempt adjustments until the engine has been shut down for at least one hour. Remove the air cleaner to expose the carburetor throat. Loosen the screw which secures the choke body assembly. Refer to Fig. 1-4 for correct choke setting according to temperature. Use a drill rod or the shank of a drill bit to measure the choke opening. Rotating the choke body clockwise richens and counterclockwise leans the choking effect. Tighten screw that secures choke body.

If choke does not operate, or will not maintain adjustment, disassemble it for repair (refer to Maintenance and Repair section).

ENGINE
MAINTENANCE AND REPAIR

Refer to the Trouble Shooting Chart for assistance in locating and correcting troubles which may occur. If a major repair or overhaul becomes necessary, the engine should be carefully checked and necessary repairs made by a competent mechanic. Major generator repairs should be made by a competent electrician. Maintain factory limits and clearances as given in the Table of Clearances, replacing worn parts when necessary. Avoid accidental shorts by disconnecting the battery when servicing control parts.

TABLE OF CLEARANCES

	Minimum	Maximum
Tappets – at 70°F	0.010"	0.012"
Valve Stem in Guide-Intake	0.001"	0.0025"
Valve Stem in Guide-Exhaust	0.0025"	0.004"
Valve Seat Interference Width	1/32"	3/64"
Valve *Face* Angle	44°	
Valve *Seat* Angle	45°	
Valve Interference Angle	1°	
Crankshaft Main Bearings		
Steel-Backed Aluminum	0.002"	0.003"
Crankshaft End Play	0.006"	0.012"
Camshaft Bearings	0.0015"	0.003"
Camshaft End Play	0.003"	
Connecting Rod Bearing (Forged Rod)	0.0005"	0.002"
Connecting Rod End Play	0.002"	0.016"
Timing Gear Backlash	0.002"	0.003"
Oil Pump Gear Backlash	0.002"	0.005"
Piston to Cylinder (Measured Below Oil Ring and Across from Wrist Pin)	0.006"	0.008"
Piston Pin in Piston at 70°F	Thumb Push Fit	
Piston Pin in Rod at 70°F	0.0001"	0.0006"
Piston Ring Gap in Cylinder	0.010"	0.023"
Breaker Point Gap (Full Separation)	0.020"	
Spark Plug Gap – For Gaseous Fuel	0.018"	
Spark Plug Gap – For Gasoline Fuel	0.025"	
Crankshaft Main Bearing Journal		
Standard Size	1.9995"	2.000"
Crankshaft Rod Bearing Journal – Standard Size	1.6255"	1.6260"
Cylinder Bore – Standard Size	3.249"	3.250"
Ignition Timing Advance	24° BTC	

CARBURETOR

The gasoline carburetor is a horizontal draft type. The carburetor consists of three major sections – the bowl and float, the idle circuit, and the load circuit.

Removal and Disassembly:

1. Remove the fuel line, governor linkage and choke wires.
2. Remove the air cleaner from the carburetor.
3. Remove the two carburetor mounting nuts and pull off the carburetor
4. Remove the two screws that mount the choke to the carburetor and remove the assembly.
5. Remove the float bowl nut and remove the bowl.
6. Remove the float pin and float.
7. Lift out the float valve and unscrew its seat.
8. Remove the no load adjusting needle.
9. Remove the load adjusting needle and spring.
10. Remove the throttle plate screws (use a file because the screws are split for locking) and the plate. Pull out the throttle shaft.

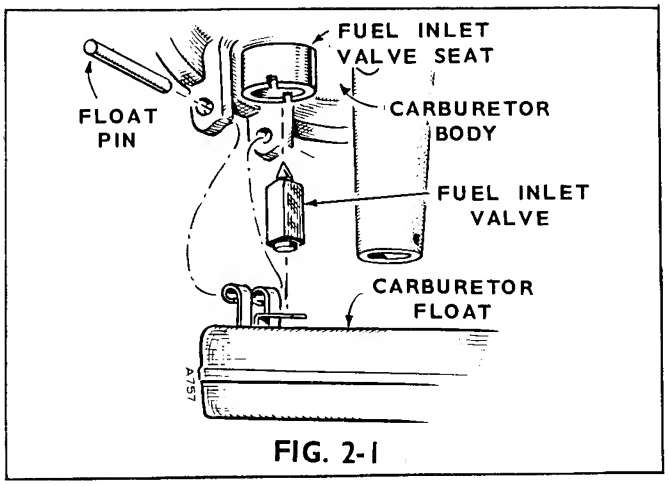


FIG. 2-1

11. Remove the choke plate screws and plate and pull out the choke shaft.

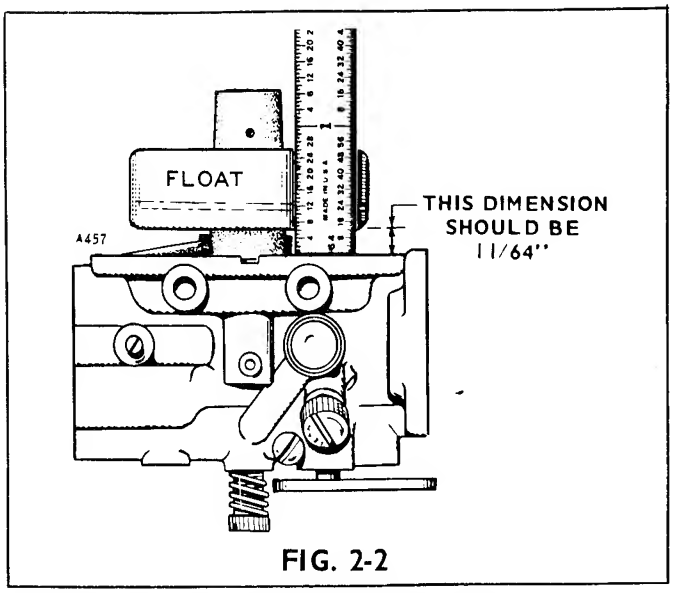


FIG. 2-2

Cleaning and Repair: To clean the carburetor, soak all components thoroughly in a good carburetor cleaner, following the cleaner manufacturer's instructions. Be sure all carbon is cleaned from the carburetor bore, especially in the area of the throttle valve. Blow out the passages with compressed air. If possible, avoid using wire to clean out the passages.

Check the adjusting needles and nozzle for damage. If the float is loaded with fuel or damaged, replace it. The float should fit freely on its pin without binding. Invert the carburetor body and measure the float level, Fig. 2-2.

If necessary, bend the small lip that the inlet valve rides on to adjust float level.

Check the choke and throttle shafts for excessive side play and replace if necessary. Do not remove the coating on the throttle shaft. This is teflon, used to reduce wear and friction between the shaft and carburetor body.

Assembly and Installation:

1. Install the throttle shaft and valve, using new screws and lockwashers. Install with bevel mated to the carburetor body. On valve plates marked with the letter C, install with mark on side toward idle port when viewed from flange end of carburetor. To center the valve, back off the stop screw, close the throttle lever, and seat the valve by tapping it with a small screwdriver; then tighten the two screws.
2. Install choke shaft and valve. Center the valve in the same manner as the throttle valve (step 1). Use new screws and lockwashers.
3. Install the main nozzle, making sure it seats in the body casting.
4. Install the inlet valve seat and valve.
5. Install the float and float pin. Center the pin so the

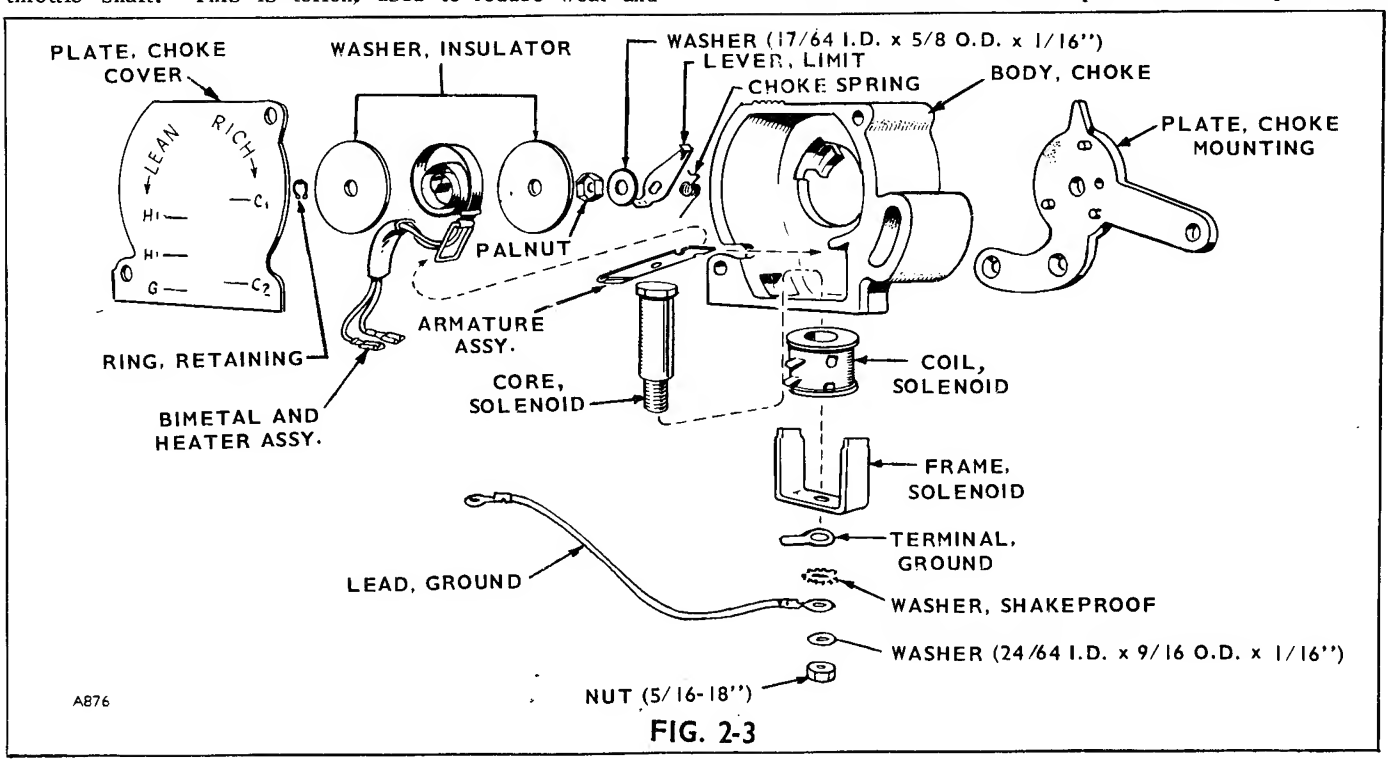


FIG. 2-3

float bowl does not ride against it.

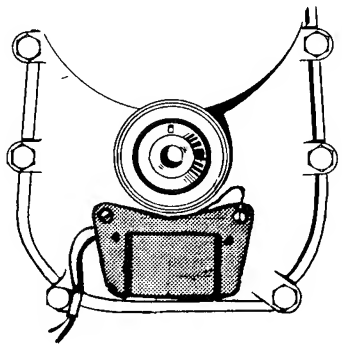
6. Check the float level with the carburetor casting inverted. See Fig. 2-2.
7. Install the bowl ring gasket, bowl and bowl nut. Make sure that the bowl is centered in the gasket, and tighten the nut securely.
8. Install the load adjusting needle with its spring. Turn in until it seats and back out 1 to 1-1/2 turns.
9. Install the idle adjusting screw finger tight. Then back out 1 to 1-1/2 turns.
10. Install the choke and adjust.
11. Install the carburetor on the engine and connect the gasoline inlet, governor mechanism, breather hose, and choke.
12. Install the air cleaner.

CHOKE

Disassembly and Repair: If the choke does not operate, or will not maintain its adjustment, disassemble it for repair. If it will not close, check for binding, incorrect adjustment, or incorrect assembly of the coil. If it will not open after plant starts, check for heating. The choke should be warm to the touch within a minute or two of plant starting.

To disassemble choke refer to Fig. 2-3.

If choke will not heat properly, check for broken heater wire, high resistance connections or broken lead wires to the bi-metal and heater assembly. With the element at room temperature, check the heater resistance with an ohmmeter. The resistance should be about 30.6 to 37.4 ohms for a 12-volt system. If the heater is defective, replace it with a new one. When the start button is engaged, the solenoid should cause the spring-loaded armature to contact the solenoid core. If this does not occur, check for broken lead wires or a defective solenoid coil. There must be slack in the lead wires between the choke body and the bi-metal and heater assembly. The solenoid coil should have a resistance of 2.09 to 2.31 ohms in a 24-volt system.



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If flywheel rubs on pole shoe loosen pole shoe mounting screws, tap pole shoe and retighten mounting screws.

FIG. 2-4

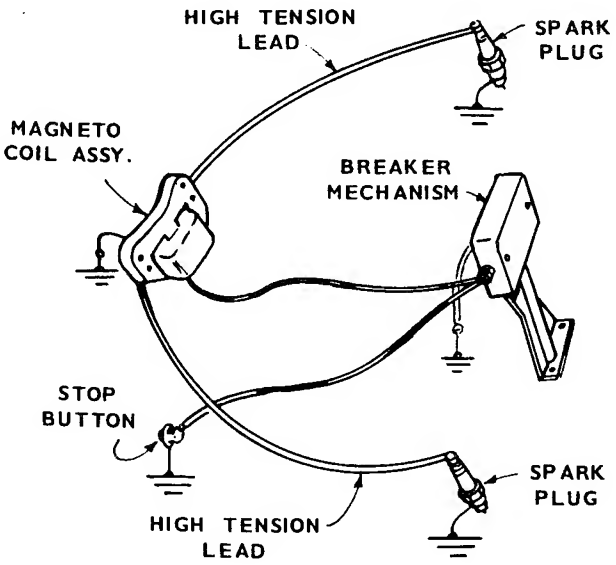

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FIG. 2-5

Assembly – Refer to Fig. 2-3. When assembling the thermo-magnetic choke, connect the bi-metal and heater assembly as follows:

1. Lead tagged G to ground terminal on coil solenoid.
2. Lead tagged H to either of the H1 terminals on the solenoid core.

MAGNETO STATOR INSTALLATION

The magneto stator assembly is mounted on the gear cover and the flywheel must be removed to expose it. Connect the stator larger lead to the breaker box insulated terminal which also connects to the ignition coil (engines *without* spark advance mechanism) and breaker points. Be sure the larger lead is held in place to prevent rubbing on the flywheel. Install two washers between the gear cover and the magneto stator on both mounting screws.

Engines *with* spark advance mechanism the stator coil includes both the primary and secondary windings. There is no separate automotive type coil used.

IGNITION COIL INSTALLATION

Coil connections differ between magneto ignition plants and battery ignition plants. Refer to the illustration which applies. The ignition coil is grounded on magneto ignition plants but not grounded with battery ignition.

TIMING THE IGNITION (Engines without Spark Advance Mechanism)

Ignition timing procedure is the same for manual-start type

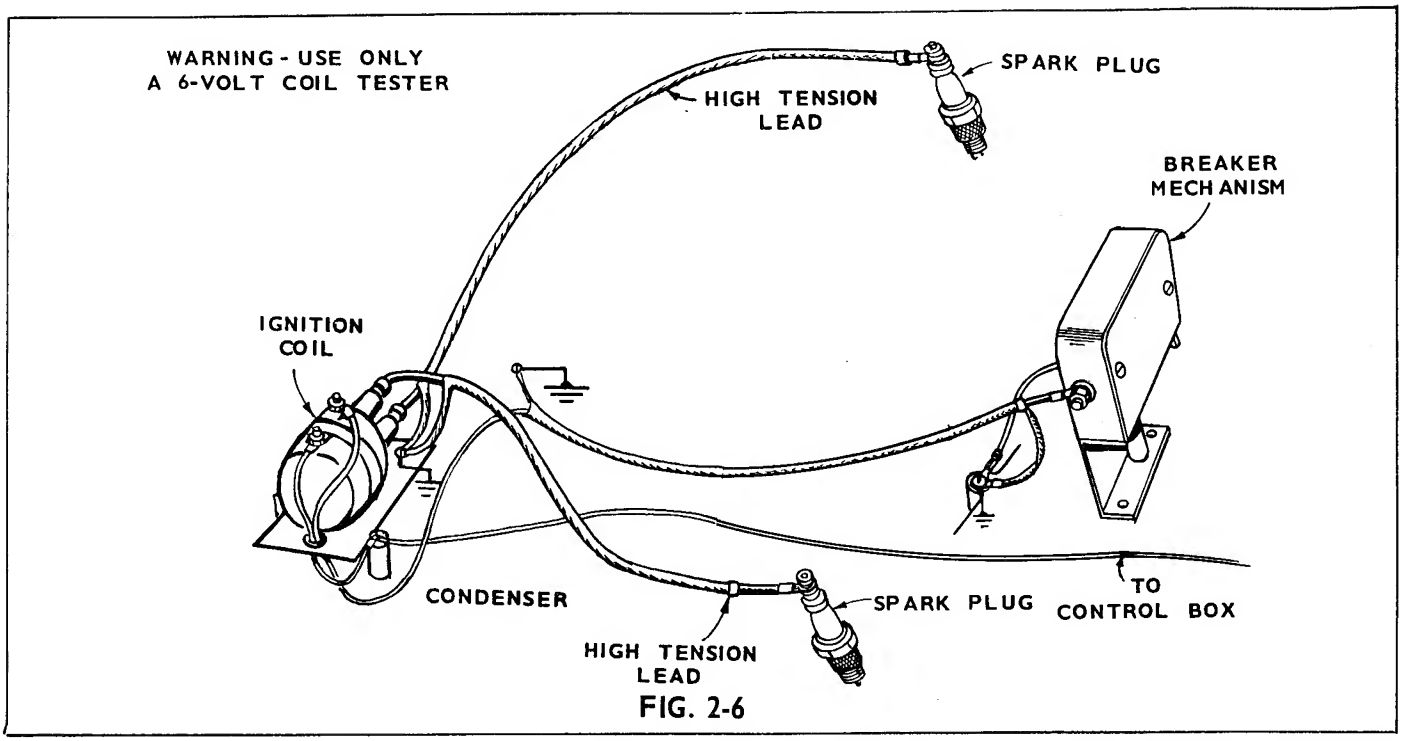


FIG. 2-6

plants with magneto ignition as for remote-start type plants with 12-volt battery ignition.

The spark advance is 24° before top center for all models. The correct timing is stamped on the cylinder block near the breaker box also.

Timing procedure follows:

1. Remove the cover from the breaker box. If the timing is very far off, attain an approximate setting by loosening the mounting screws and shifting the breaker box (and spacer if used) to align the witness marks on the cylinder block and breaker box (or spacer).
2. Crank the engine over slowly by hand in the direction of crankshaft rotation until the witness mark on the flywheel and the TC mark on the gear cover are exactly in line. See the illustration Ignition Timing Fig. 2-7.
3. Adjust the ignition breaker point gap width to .020" at full separation.
4. Turn the flywheel to the left, against crankshaft

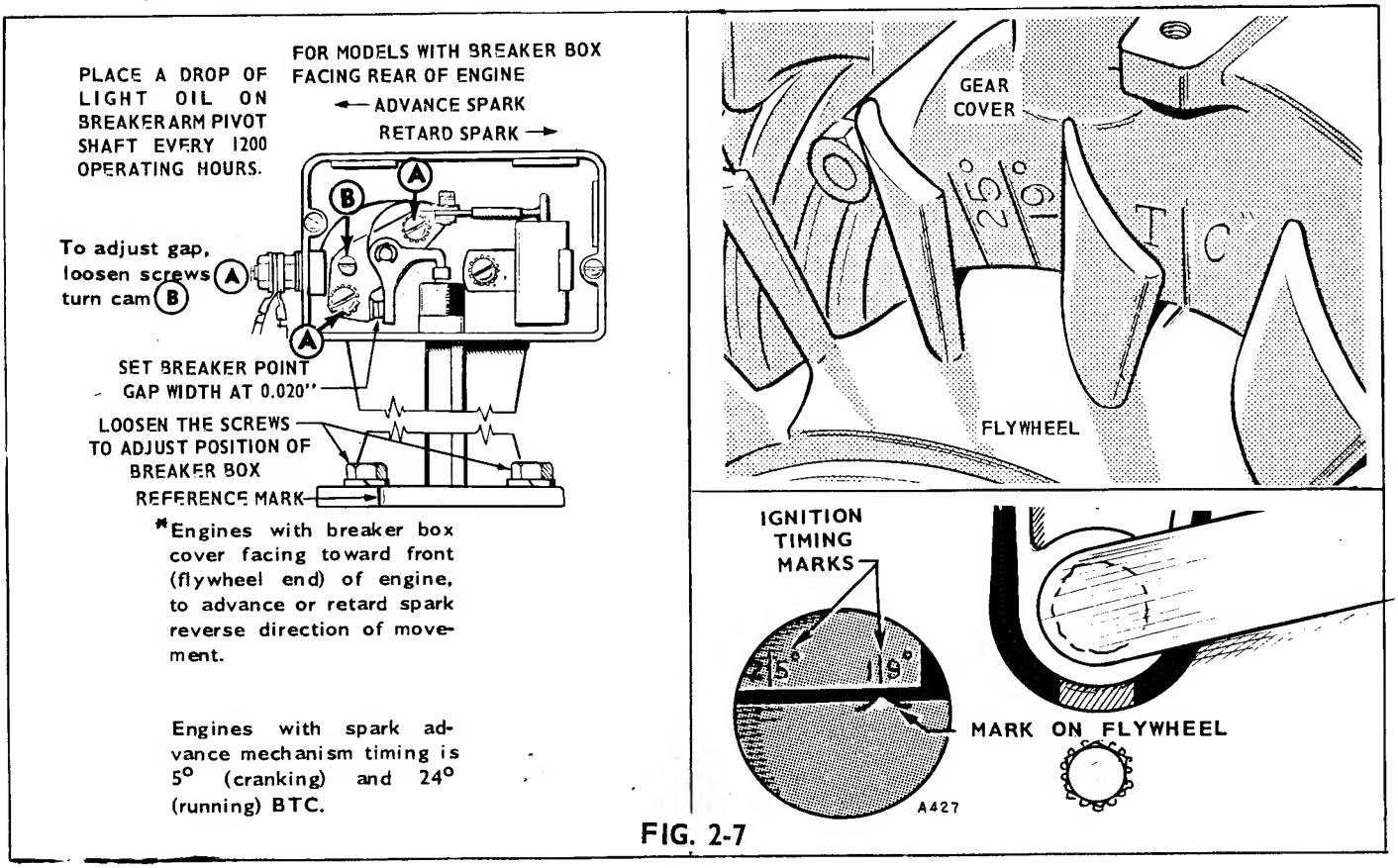


FIG. 2-7

rotation, until the timing mark is about 2" past the 25° mark on the gear cover.

5. Turn the flywheel slowly to the right and note whether the ignition points just separate when the mark on the flywheel aligns with the correct degree mark (24°) on the gear cover. If the marks align as the points break, timing is correct. If they do not, loosen the breaker box mounting screws and shift the whole breaker box assembly slightly toward the #1-cylinder to retard the timing (points breaking too soon), or shift is slightly away from the #1-cylinder to advance the timing (points not breaking soon enough). Tighten the breaker box mounting screws securely after making an adjustment. Refer to the illustration, Fig. 2-7.

   To accurately check the time at which the spark occurs, an automotive type timing light may be used when the engine is running.

   To accurately check the time at which the spark occurs when not running the engine, connect a continuity test lamp set across the ignition breaker points. Touch one test prod to the breaker box terminal (to which the lead to the coil is connected), and touch the other test prod to the breaker box terminal (to which the lead to the coil is connected), and touch the other test prod to a good ground on the engine. Turn the crankshaft against rotation (backwards) until the points close. Then slowly turn the crankshaft with rotation. The lamp should go out just as the points break.
6. Install the breaker box cover.

TIMING THE IGNITION (Engines with Spark Advance Mechanism)

Instructions for timing are the same except the timing are the same except the timing marks differ and are marked on the flywheel. The correct timing of 5° (cranking) – 24° (running) is stamped on crankcase near the breaker box, and also marked on the flywheel. To time the ignition with engine stopped or at idle speed using a timing light, the 5° marking on the flywheel should align with the TC marking on the gear cover. To time the ignition with a timing light when engine is running at 1,100-rpm or over, the 24° marking on flywheel should align with the TC marking on the gear cover. If the timing marks align as the points break, the timing is correct. Timing adjusted while running is preferred.

SPARK ADVANCE MECHANISM

The spark advance mechanism is located on the rear end of the camshaft. It is operated by centrifugal force. As the engine speeds up, the weights push the cam advancing the spark, or release the cam retarding the spark as engine speed is decreased.

If the spark advance mechanism should become dirty or gummy, causing the mechanism to stick closed (retarded), the engine will be low of power. If the mechanism sticks open (advanced), the engine would possibly kick back on cranking. The spark advance mechanism can be reached for cleaning by either removing the cup shaped cover in cylinder block camshaft opening to expose mechanism or by removing camshaft from engine. Do not indent the cup shaped cover as it will interfere with the weight mechanism.

FLYWHEEL

To remove the flywheel turn the flywheel mounting screw outward about two turns. Use a screwdriver behind the flywheel to take up the crankshaft end play. Then strike a sharp end-wise blow on the head of the cap screw with a heavy soft faced hammer to loosen. A suitable puller (with claws or with bolts to agree with flywheel) may be used to pull the flywheel.

Do not drop the flywheel. A broken fin will destroy the balance.

A magneto flywheel which has lost its magnetism can be remagnetized. The spark should jump a 3/16" gap with ease as tested by holding the spark plug wire away from a clean metal part of the engine while cranking.

VALVE SERVICE

Properly seated valves are essential to good engine performance. The aluminum cylinder head is removable for valve servicing. Do not use a pry to loosen the cylinder head, rap sharply on the edge with a soft faced hammer, taking care not to break any cooling fins. A conventional type valve spring lifter may be used when removing the valve spring locks, which are of the split type. Clean all carbon deposits from the cylinder head, piston top, valves, guides, etc. If a valve face is burned or warped, or the stem worn, install a new valve.

Worn valve stem guides may be replaced from inside the valve chamber. Valve locks are the split, tapered type, the smaller diameter of which must face toward the valve head. Tappets are also replaceable from the valve chamber, after first removing the valve assemblies.

The valve *face* angle is 44°. The valve *seat* angle is 45°. This 1° interference angle results in a sharp seating surface between the valve and the top of the valve seat. The interference angle method of grinding valves minimizes face deposits and lengthens valve life.

The valves should not be hand lapped, if at all avoidable, since the sharp contact may be destroyed. This is especially important where hard alloy faced valves and seats are used. Valve faces should be finished in a machine to 44°. Valve seats should be ground with a 45° stone, and the width of the seat band should be 1/32 to 3/64 of an inch wide. Grind only enough to assure proper seating.

Remove all grinding dust from engine parts and install each valve in its proper location. Check each valve for a tight seat, using an air pressure type testing tool. If such a tool

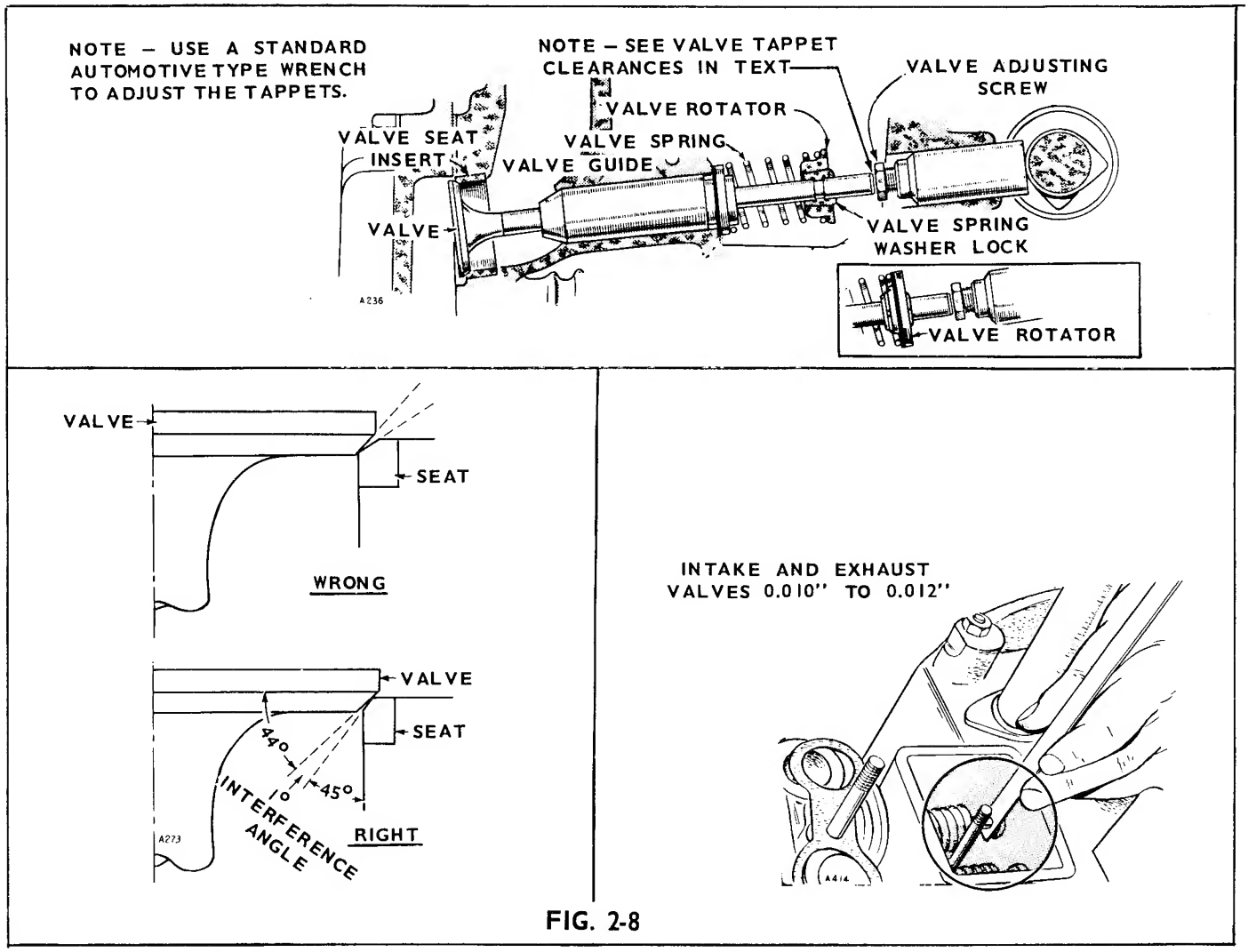


FIG. 2-8

is not available, make pencil marks at intervals across the valve face and observe if the marks rub off uniformly when the valve is rotated part of a turn against the seat.

Lightly oil the valve stems and assemble all parts removed. Adjust the valve clearance.

The positive type valve rotocaps serve to prolong valve life and need for valve service. When functioning properly, the valve is rotated a fraction of a turn each time it opens. While at open position, the valve can be rotated freely but in only one direction. If rotocaps are faulty, install new rotocaps.

TAPPET ADJUSTMENT

These plants are equipped with adjustable tappets. To make a valve adjustment, remove the valve covers. Crank the engine over slowly by hand until the left hand intake valve,

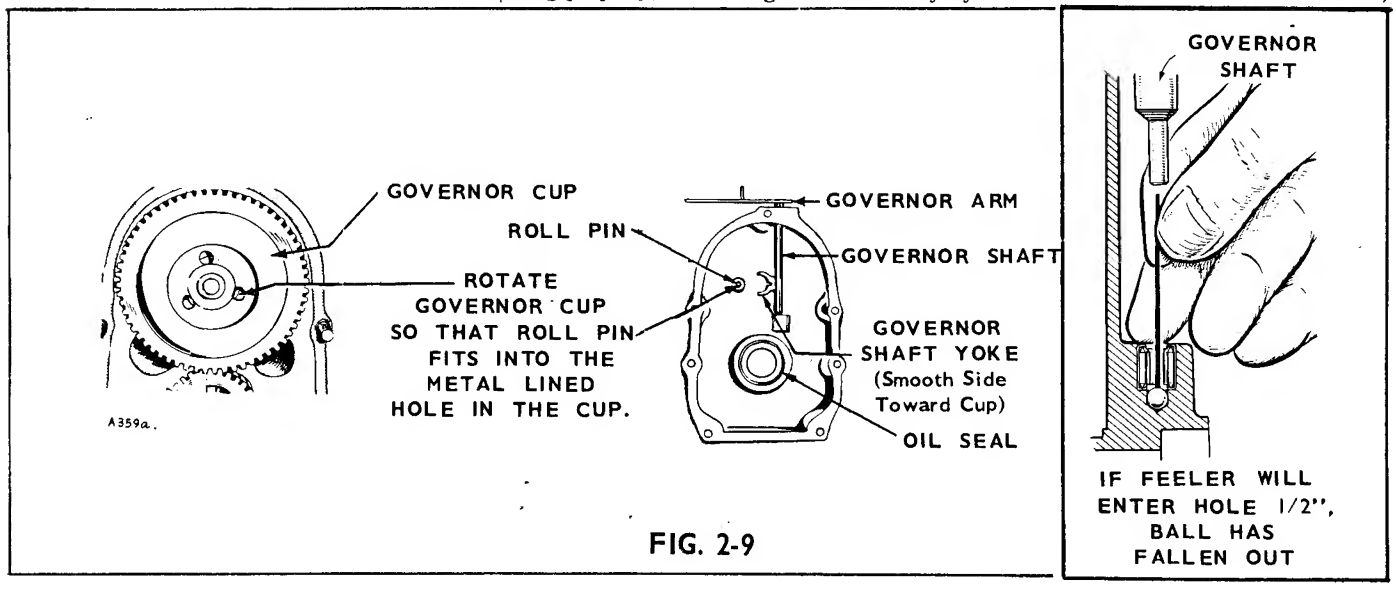


FIG. 2-9

when facing the flywheel, opens and closes. Continue about 1/4 turn until the mark on the flywheel and the TC mark on the gear cover are in line. This should place the left hand piston at the top of its compression stroke, the position it must be in to get proper valve adjustment for the left hand cylinder. Clearances are shown in the Table of Clearances. For each valve, the thinner gage (minimum) should pass freely between the valve stem and valve tappet but the thicker gage (maximum) should not. Refer to the illustration, Fig. 2-8.

To correct the valve clearance, simply turn the adjusting screw as needed to obtain the right clearance. The screw is self-locking and will stay where set.

If valve clearance can no longer be held within given limits, replace the valve.

To adjust the valves on the right hand cylinder, crank the engine over one complete revolution and again line up the mark on the flywheel and the TC mark on the gear cover. Then follow the adjustment given for the valves of the left hand cylinder.

GEAR COVER

After removing the mounting screws, tap the gear cover gently with a soft faced hammer to loosen it.

When installing the gear cover, make sure that the pin in the gear cover engages the metal lined (smoothest) hole in the governor cup. Turn the governor cup so that the metal lined hole is at the 3 o'clock position. The smooth side of the governor yoke must ride against the governor cup. Turn the governor arm and shaft clockwise as far as possible and hold in this position until the gear cover is installed flush against the crankcase. Be careful not to damage the gear cover oil seal. Adjust the roll (stop) pin to protrude to a point 3/4" from the covers mounting surface.

GOVERNOR CUP

With the gear cover removed, the governor cup can be taken off after removing the snap ring from the camshaft center pin. Catch the flyballs while sliding the cup off.

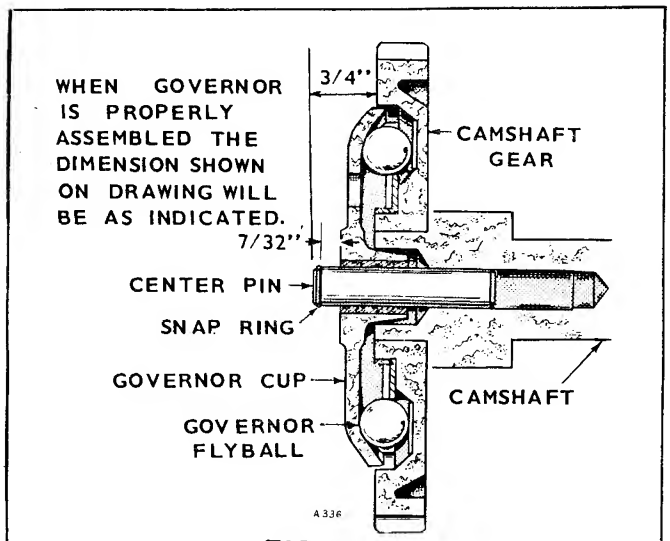


FIG. 2-10

Replace with a new part, any flyball which is grooved or has a flat spot, the ball spacer if its arms are worn or otherwise damaged, and the governor cup if the race surface is grooved or rough. The governor cup must be a free spinning fit on the camshaft center pin, but without any looseness or wobble.

When installing the governor cup, tilt the engine so the gear is up, put the flyballs in place (equally spaced), and install the cup and snap ring on the camshaft center pin.

The camshaft center pin extends out 3/4" from the end of the camshaft. This distance provides an in and out travel distance of 7/32" for the governor cup, as illustrated. Hold the cup against the flyballs when measuring. If the distance is less (the engine may race especially at no load), remove the center pin and press a new pin in only the required amount. Otherwise, grind off the hub of the cup as required. The camshaft center pin cannot be pulled outward nor removed without damage. If the center pin extends out too far, the cup will not hold the flyballs properly.

TIMING GEARS

If replacement of either the crankshaft gear or the camshaft gear becomes necessary, install both gears new, never one only. To remove the crankshaft gear, first remove the snap

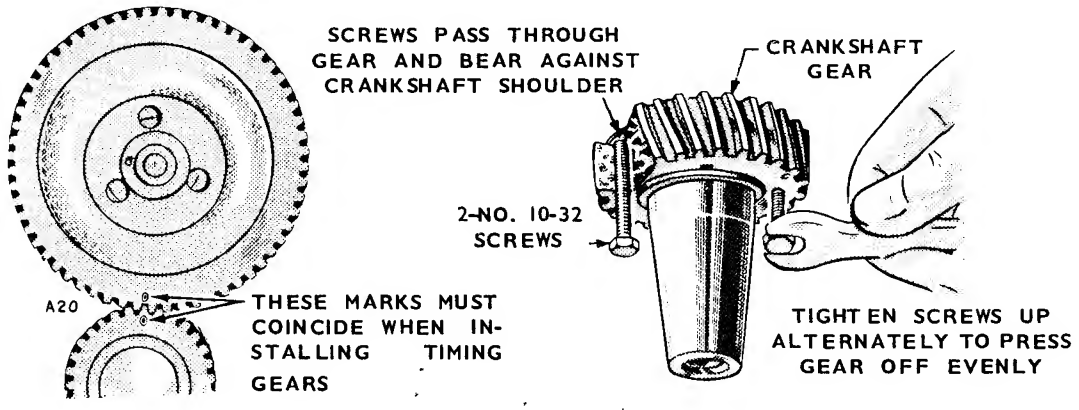


FIG. 2-11

ring, then insert two long #10-32 steel screws into the tapped gear holes and tighten the screws alternately. As the screws are tightened, the screw ends will seat against the crankshaft shoulder and force the gear off the end of the crankshaft.

The camshaft gear is pressed on and keyed to the camshaft. The camshaft and gear must be removed as an assembly, after first removing the crankshaft gear lock ring and washer. Before removing the camshaft and gear assembly, remove the cylinder head and valve assemblies. Remove the operating plunger for the breaker points. Remove the fuel pump and tappets. After removing the governor cup assembly from the gear, the camshaft may be pressed out of the gear by use of a hollow tool or pipe which will fit over the camshaft center pin. Do not press on the center pin or damage it in any way. The governor ball spacer is a press fit to the camshaft gear.

When pressing a camshaft gear onto the camshaft, be sure the gear is started straight and that the key is properly in place. Install the governor cup assembly before installing the camshaft and gear in the engine.

Note that each timing gear is stamped with O mark near the edge. The gear teeth must mesh so that these marks exactly coincide when the gears are installed in the engine. Be sure, when installing the camshaft gear and shaft assembly, that the thrust washer is properly in place behind the camshaft gear. Replace the retaining washer and lock ring to the crankshaft.

CYLINDER

The cylinder wears very little in normal service. If, through improper lubrication or accident, the cylinder wall should become scored or worn badly, the cylinder may be rebored and honed to accommodate a new piston and rings of one of the available oversizes. Pistons and rings are available in .010", .020", .030" and .040" oversizes. An engine may have been fitted at the factory with .005" oversize pistons, and will be so indicated by the letter E following the engine serial number stamped on the cylinder block and on the plant nameplate. Use standard size rings on a .005" oversize piston. If the cylinders are not being reconditioned, but new piston rings are being installed, remove any ridge which may have become formed at the top of piston ring travel in the cylinder bore.

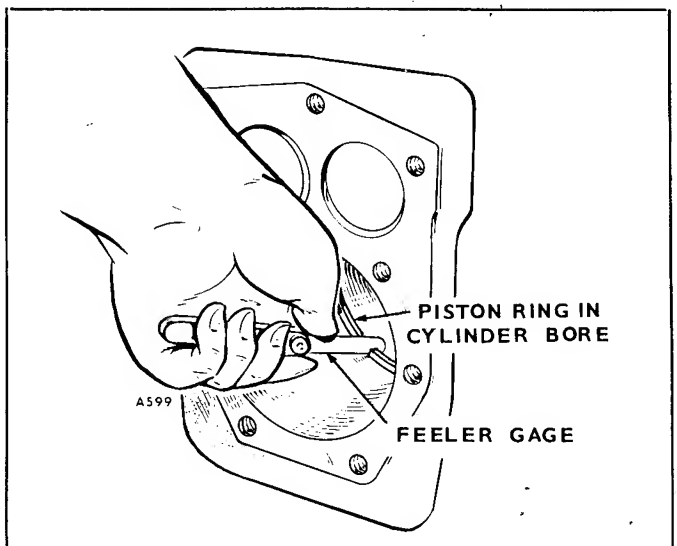


FIG. 2-12

PISTONS AND RINGS

The piston and connecting rod assemblies are removed through the top of the cylinder. The pistons are fitted with two compression rings and one oil control ring with an expander. Inspect each piston. The piston ring grooves should be cleaned of any carbon deposits, and the oil return holes in the lower groove must be open.

If the pistons are badly scored, very loose in the cylinders, have badly worn ring grooves, or otherwise are not in good condition, install new pistons. Install new pistons if the old ones are loose on the piston pins and .002" oversize piston pins will not correct it. Handle pistons carefully to avoid nicking the walls. Any raised surface of this type must be dressed down carefully.

Inspect the rings carefully for fit in grooves, for tension, and for seating on cylinder walls. Install new rings where there is any doubt about the condition of the old rings.

Before installing new rings on the piston, check the ring gap by placing each ring squarely in its cylinder at a position corresponding to the bottom of its travel. The gap between the ends of the ring should be as given in the Table of Clearances. Rings which are slightly oversize may be filed as necessary to obtain the correct gap, but do not use rings which require too much filing. Standard size rings may be used on a .005" oversize piston. .010", .020", .030" and .040" oversize rings are to be used on .010", .020", .030" and .040" oversize pistons, respectively. Rings of the tapered type are usually marked *top* on one side, or identified in some other manner, and the ring must be installed with this mark toward the closed end of the piston. Space each ring gap one third of the way around the piston from the preceding one, with no gap directly in line with the piston pin. The bottom piston ring groove should be fitted with an expander and an oil control ring and the two upper grooves fitted with compression rings. If a chrome faced ring is used, it will be in the top groove. The oil control ring is selected for best performance in regard to the correct unit pressure characteristics.

The piston is fitted with a full floating type piston pin. The pin is kept in place by two lock rings in the piston, one at each side. Be sure these lock rings are properly in place before installing the piston and connecting rod in the engine.

Each piston pin should be a thumb push fit into its piston at room temperatures. If the pin is excessively loose, install a new one. If the condition is not corrected, install the next oversize pin. If the piston is worn enough that the oversize pin will not fit, replace the piston.

Correct piston to cylinder clearance appears in the Table of Clearances.

CONNECTING RODS

The connecting rods should be serviced at the same time the pistons or piston rings are serviced. Rods must be removed with the piston. Rods are forged steel with replaceable bushings and bearings. Rods are available in standard or .010", .020" or .030" undersize. Bearings are available in standard or .002", .010", .020" or .030" undersize.

For fits refer to the *Table of Clearances*.

Proper clearance is obtained by replacing the pin bushing and the bearings. The rod bearings are precision size and require no reaming.

The connecting rod and piston assembly must be properly aligned before re-assembly to the engine. The aligning should be done on an accurate aligning gage by a competent operator. Misalignment may cause rapid wear of piston, pin, cylinder and connecting rod.

Install the connecting rods and caps with raised lines (witness marks) aligned, and with the caps facing toward the oil base. The rod and cap numbered two fits on the crankshaft journal nearer the bearing plate. Coat the crankshaft journal bearing surfaces with oil before installing the rods. Crank the engine by hand to see that the rods are free. If necessary, rap the connecting rod cap screws sharply with a soft faced hammer to set the rod square on the journal.

BEARINGS

Removal of the camshaft or crankshaft bearings requires complete disassembly of the engine. Use a press or a suitable drive plug to remove the bearings. Support the casting to avoid distortion and avoid damaging the bearing bore during removal and installation. Use oil on bearings to reduce friction when installing and again lubricate with oil after installing.

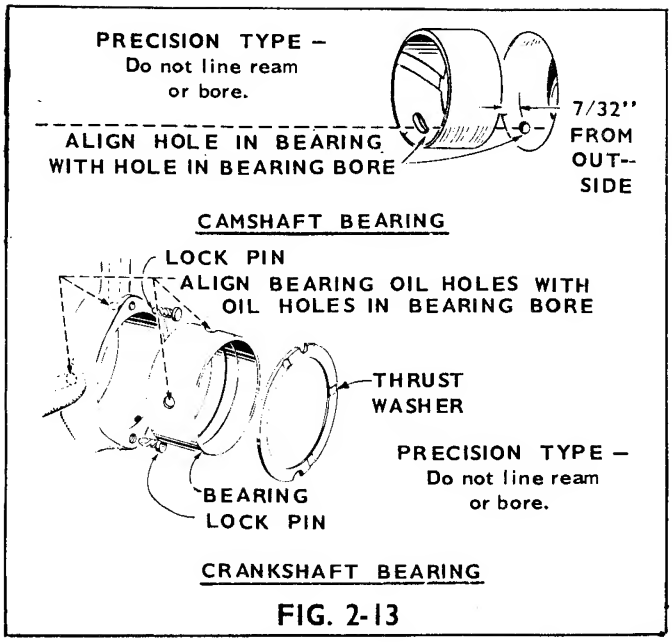


FIG. 2-13

New crankshaft main bearings are precision type which *do not* require line reaming or line boring after installation. They are available in standard or .002", .010", .020" or .030" undersize. Expand the bearing bore by placing the casting in hot water or in an oven heated to 200°F. Be careful, if a torch is used, to apply only a little heat. If practical, cool the precision bearing to shrink it. Align the oil hole(s) in bearing with the oil hole(s) in bearing bore. The oil passage must be at least 1/2 open. The cold oiled precision bearing should require only light taps to position it. Install the bronze faced bearing flush with the inside end of bore. If head of lock pin is damaged, use side cutters or Easy-out tool to remove and install new pin. Apply oil to thrust washer to hold it in place while installing the crankshaft. Oil grooves in thrust washers must face the crankshaft, washers must be flat (not bent) and washers two notches must fit over two lock pins to prevent riding on crankshaft.

New camshaft bearings are precision type which *do not*

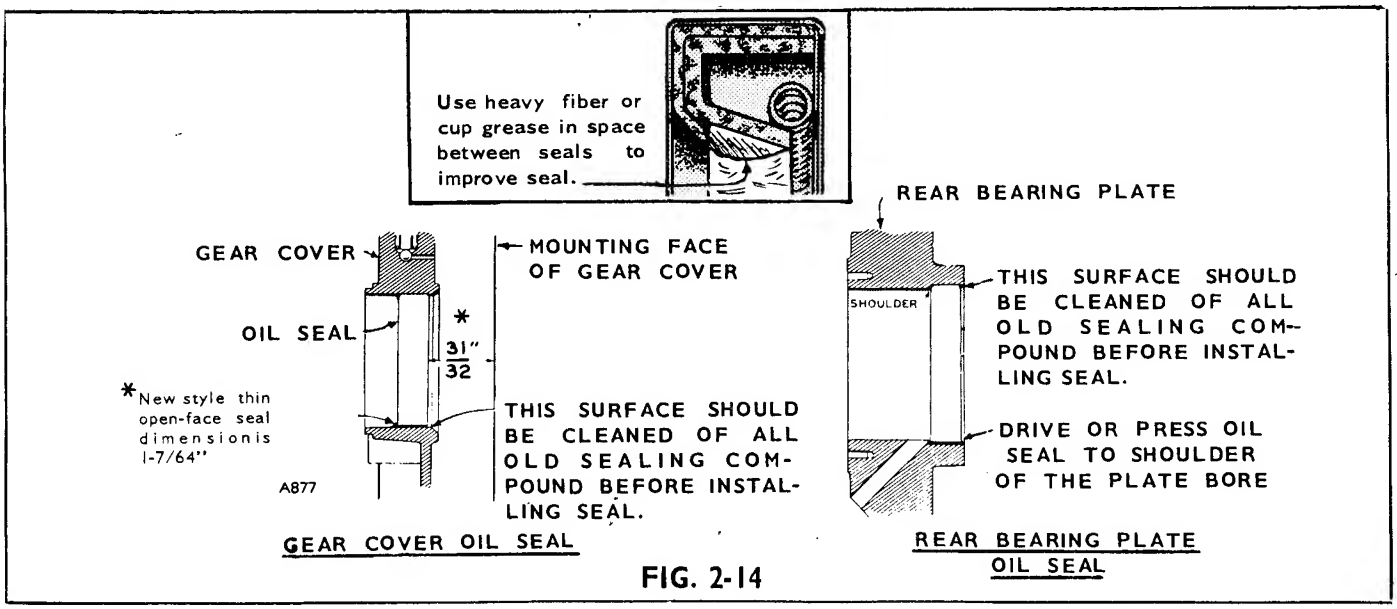


FIG. 2-14

require line reaming or line boring after installation. Coat the bearing with lubricating oil to reduce friction. Place the bearing on the crankcase over the bearing bore with the elongated hole in proper position and narrow section facing out (except bores without oil holes install with bearing groove at the top). Be sure to start the bearing straight. Press the front bearing in flush with the outside end of the bearing bore. Press the rear bearing in flush with the bottom of counterbore which receives the expansion plug.

Clean the bearing and re-coat it with oil before installing the camshaft. Install the expansion plug of the rear bearing.

OIL SEALS

The gear cover must be removed to replace its oil seal. Drive the oil seal out from the inside of the gear cover.

The bearing plate must be removed to replace its oil seal. Drive the oil seal out from the inside.

Before installing the seals, fill the space between lips with a fiberous grease or stiff cup grease. This will improve sealing.

When installing the gear cover oil seal, tap the seal inward until it is 31/32 of an inch from the mounting face of the cover. Install new style, thin, open-face seal 1-7/64" from mounting face of cover.

When installing the bearing plate oil seal, tap the seal into the bearing plate bore to bottom against the shoulder in the plate bore. Use a seal expander, or place a piece of shim stock around the end of the crankshaft, when replacing the bearing plate to avoid damaging the seal. Remove the shim stock as soon as the plate is in place.

CRANKSHAFT

Inspect the bearing journals. If they are scored and cannot be smoothed out by dressing down, the bearing journals should be refinished to use nearest available undersize bearings or a new crankshaft should be installed. If a worn main bearing journal cannot be fitted with an available precision type undersize bearing, then refinish it to the next undersize. If a worn rod journal cannot be fitted by installing new bearing inserts, refinish it to take the corresponding undersize bearing insert available.

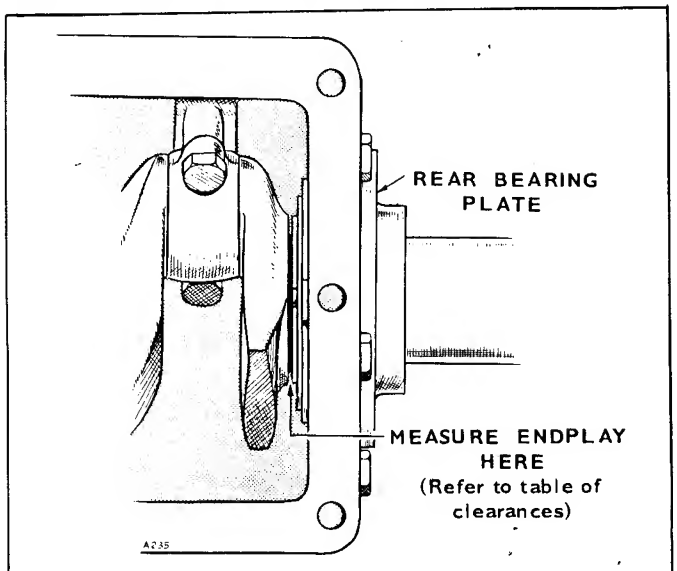


FIG. 2-15

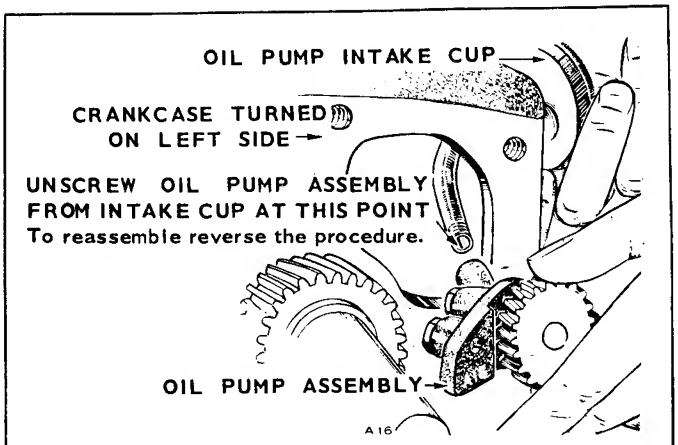


FIG. 2-16

Whenever making major repairs on the engine, always inspect the drilled passages of the crankshaft. Clean them to remove any foreign material and to assure proper lubrication of the connecting rods.

Crankshafts with H stamped on the counterweight have induction hardened main bearing journals and should use steel backed aluminum bearings.

When installing the crankshaft, use gaskets as needed behind the bearing plate to assure end play as given in the Table of Clearances.

OIL PUMP

To remove the oil pump, it is necessary to detach the intake cup assembly, as illustrated.

Check the oil pump thoroughly for worn parts. Oil the pump to prime it before reinstalling. Except for gaskets, the component parts of the pump are not available individually. The intake cup is available separately. Install a new pump assembly if required.

FUEL PUMP

A diaphragm type fuel pump is used. If fuel does not reach the carburetor, check the fuel pump before dismantling it. The pump can be checked by disconnecting the fuel line at the carburetor, cranking the engine slowly by hand, and observing whether fuel comes from the line at the carburetor. If there is enough fuel in the tank, and the line between the tank and the pump is open but the pump fails, repair or replace it. Failure of the pump is usually due to a leaking diaphragm, valve or valve gasket, a weak or broken spring, or wear in the drive linkage. If the operator chooses to repair the pump rather than install a new one, the use of a complete repair kit is recommended.

Always return the hand priming lever all-the-way inward so that the priming lever does not prevent the normal operation of the pump. If the fuel pump rocker arm is being lifted by the camshaft, the engine must be cranked 1-revolution before the priming lever will be effective.

Rotating the diaphragm 1/4 turn will disengage the drive link.

Gasoline diluted oil may indicate a faulty fuel pump.

GASKETS

Always use new gaskets when replacing any part that requires a gasket. Thoroughly clean the surface that the gasket contacts before installing the gasket.

TESTING IGNITION COIL

A 6-volt tester may be used to test the ignition coil. To avoid burning out the coil, do not use a 12-volt tester and do not leave coil on tester over 15-minutes.

CRANKCASE BREATHER VALVE

If the engine begins to leak oil, the valve in the breather tube may be sticking. Remove the breather tube rubber cap, lift out the valve and inspect it. Frequently the valve will lift off with and remain in the cap. Pry it out. First soak then wash the valve in fuel or suitable solvent so the disc will work freely. Run the engine holding the valve in place to prove it opens and closes. Replace a faulty valve. Some engines use a mesh type baffle in the breather tube. If mesh appears to be dirty, gummed up and obstructing the system, carefully lift out and wash. Replace if deteriorated or damaged in any way.

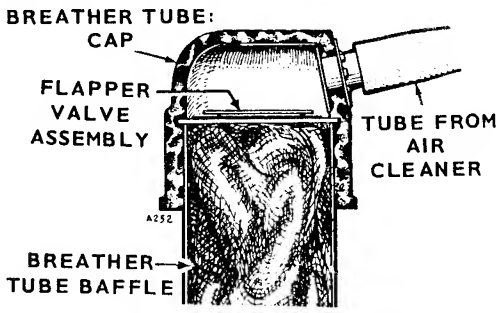


FIG. 2-17

SERVICING THE READI-PULL STARTER

Caution: *The recoil spring may unwind and cause injury if let fly wildly when starter is disassembled or reassembled.*

The sheave hub bearing (16) has a recess which was packed full of grease at the factory. Normally, no additional lubrication is required. However, if the starter is disassembled for some other reason, add grease to the bearing and to the spring pawls (11) where they contact the ratchet arm (13).

To install a new rope or internal parts, remove the starter from its mounting ring by removing the four clamping screws.

To install a new rope, rotate the sheave (10) with crankshaft rotation direction to fully tighten the spring (8), back up only as necessary to align the hole in the sheave with the slot in the cover (5), clamp the rope to the sheave, then when released, the rope will wind on the sheave.

To install a new recoil spring, remove the sheave from the cover. Wind the spring, with its rivet heads outward, forming a coil small enough to be inserted in the recess of the starter cover. It may be necessary to tie the spring with a piece of wire to prevent its unwinding during installation unless other help is available. Place the spring in the cover recess in crankshaft rotation direction. Remove the tying wire if used. While holding the spring to prevent its unwinding install the inside end of the spring on the roll pin (7) in the cover. With the pull-rope removed install the sheave assembly in the cover so that the tab on the sheave enters the outside end loop of the recoil spring. Be sure the thrust washer (9) is in place. Then install the pull rope.

Spring breakage is much less common than spring fatigue due to long usage. In either case, the spring should be replaced. Cleaning and lubricating the pawls, and ratchet arms in the rope sheave will improve a sluggish acting recoil. To temporarily extend the life of a fatigued spring, try rewinding it *inside out* (rivets heads inward).

To install a ratchet arm (13) in the sheave, the pawl (11) must first be removed. The ratchet arm will fit in only the correct position. The spring pawl must be installed with its flat edge against the ratchet arm.

The anti-back lash cogwheel (6) is an easy press fit on the starter cover.

INSTALLING STARTER REPLACEMENT KIT

See that the engine blower housing is in good condition. If the mounting holes are worn or if the blower housing is otherwise damaged, replace it with a new one (See Fig. 3-2).

1. Install the new ratchet wheel (1) against rope sheave (11) using lock washer (10) and flywheel mounting screw (9). Discard the large flat washer from engines so equipped. Engage drive hole with flywheel boss.
2. Four special nuts are supplied for mounting the starter to the blower housing. If the blower housing is not already fitted with similar nuts, remove the blower

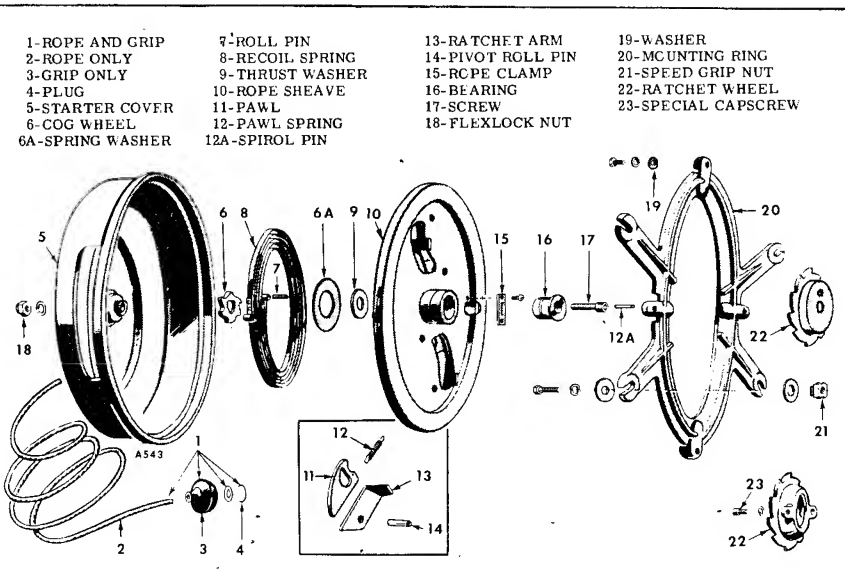
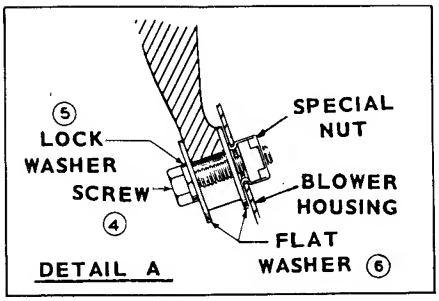
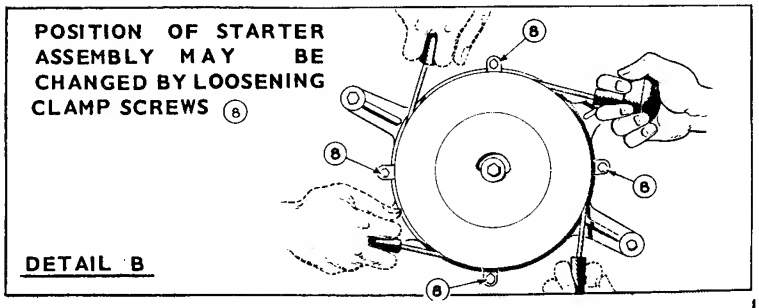


FIG. 3-1





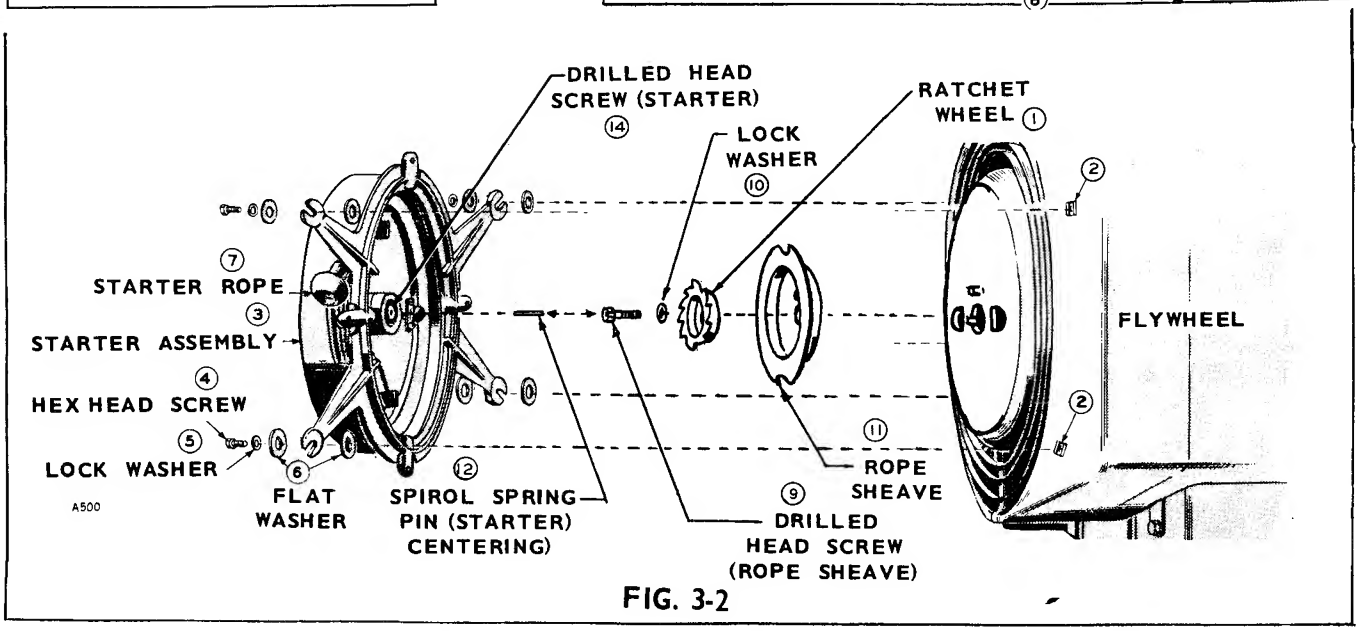


FIG. 3-2

housing and install the nuts as shown in detail A. Install the blower housing, tightening securely in place.

3. Install centering pin (12) in starter center screw (14) allowing 3/8" to protrude. For re-installations re-adjust pin depth.
4. Center the starter assembly over the ratchet wheel with the centering pin engaging the center hole of the flywheel mounting screw. While holding in position, mount the starter, using a hex head screw, lock washer, and two flat washers at each mounting arm as shown in detail A. Tighten the mounting screws securely.
5. The direction of pull on the starter rope is adjustable to fit the requirements of the individual installation. See detail B. To change the direction of pull, loosen the four clamp screws (8) and turn the starter in its mounting ring to the desired position. Tighten the four clamp screws securely. Try the starter several times, making sure that the pull rope will not rub against one of the clamp screws.

GENERATOR
MAINTENANCE AND REPAIR

The generator normally needs little care other than a periodic check of the brushes, commutator and collector rings. If a major repair job on the generator should become necessary, have the equipment checked by a competent electrician who is thoroughly familiar with the operation of electric generating equipment. Continuity tests may be performed without disassembly of the generator.

GENERATOR DISASSEMBLY

The procedure is mostly self-evident. Remove the band and end cover. Remove constant-pressure-type springs and lift all brushes.

Remove generator through stud nuts. Hold both the end bell with its brush rig and the frame assembly, since they are separate parts, and remove them as one assembly from the adapter. Screwdriver slots in the adapter provide for prying the frame loose. Be careful not to let the frame assembly rest or drag on the armature.

Turn the armature nut out to the end of the armature through stud. While pulling outward with one hand under the armature strike a sharp end-wise blow on the nut to loosen the armature. Remove the armature and blower as an assembly. The blower is a keyed and pressed fit on the armature shaft, and is a keyed and tapered fit to the engine crankshaft.

If the armature does not come loose, place a heavy brass rod on the armature shaft near the ball bearing and strike a sharp downward blow on the rod with a hammer. Rotate the armature 1/2 turn before repeating. Do not strike the commutator, collector rings, or bearing.

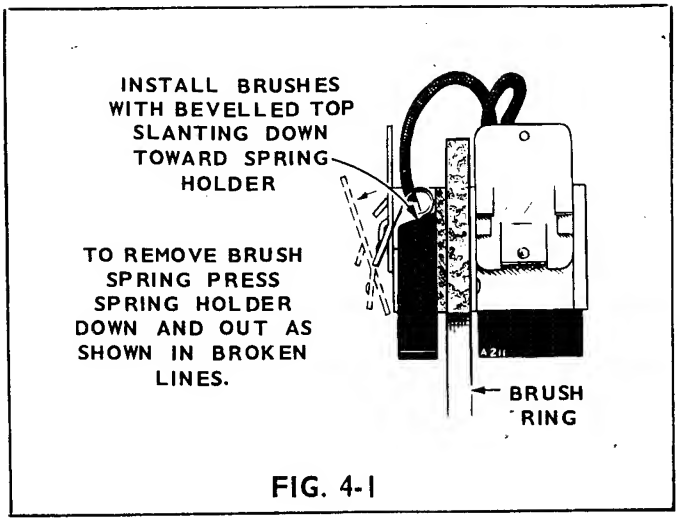


FIG. 4-1

BRUSHES AND SPRINGS

Inspect brushes periodically. Brushes worn to 5/8" should be replaced. Replace springs if damaged or if proper tension is questionable. Rapid brush wear may be caused from high mica between commutator bars, rough commutator or collector rings, or from a deviation from *neutral* position in the adjustment of the brush rig. *Never* bend the constant-pressure-type spring over the edge of its support.

BRUSH RIG POSITION

Check the witness mark on the brush rig and if necessary align it with the boss in the end bell. If the brush rig is adjusted so that there is arcing of the brushes, brush wear will be rapid, voltage and current will not hold steady, and the generator may overheat.

Whenever a new brush rig or armature is installed, the brush rig must be rotated to the point of highest voltage (point of least arcing of the brushes) regardless of where the witness mark falls. This is commonly known as the *neutral* brush position.

COLLECTOR RINGS

If the collector rings become grooved or out of round, or the brush surface becomes pitted or rough so that good brush film cannot be maintained, remove the armature and refinish the collector rings in a lathe. If the commutator appears to be rough or scored, refinish it at the same time. Remove or adequately shield the ball bearing during refinishing.

COMMUTATOR

The commutator bars wear down with usage so that the mica between them must be undercut. This should be done as soon as the mica on any part of the commutator touches the brushes. A suitable undercutting tool can be made from a hacksaw blade. Avoid injury to the surfaces of the copper bars. Leave no burrs along the edges of the bars. The mica must also be undercut whenever the commutator is refinished.

TESTING WINDINGS

A test lamp set and an armature growler are required for the various tests. Before making any tests, lift all brushes into their holders and disconnect the load circuit wires from the plant. If the armature tests defective, the practical repair is to replace it. If a field coil tests defective, replace the entire coil assembly unless the trouble is in one of the external leads. Then it can be repaired as the nature of the trouble requires. See page 20 and 21 for these tests.

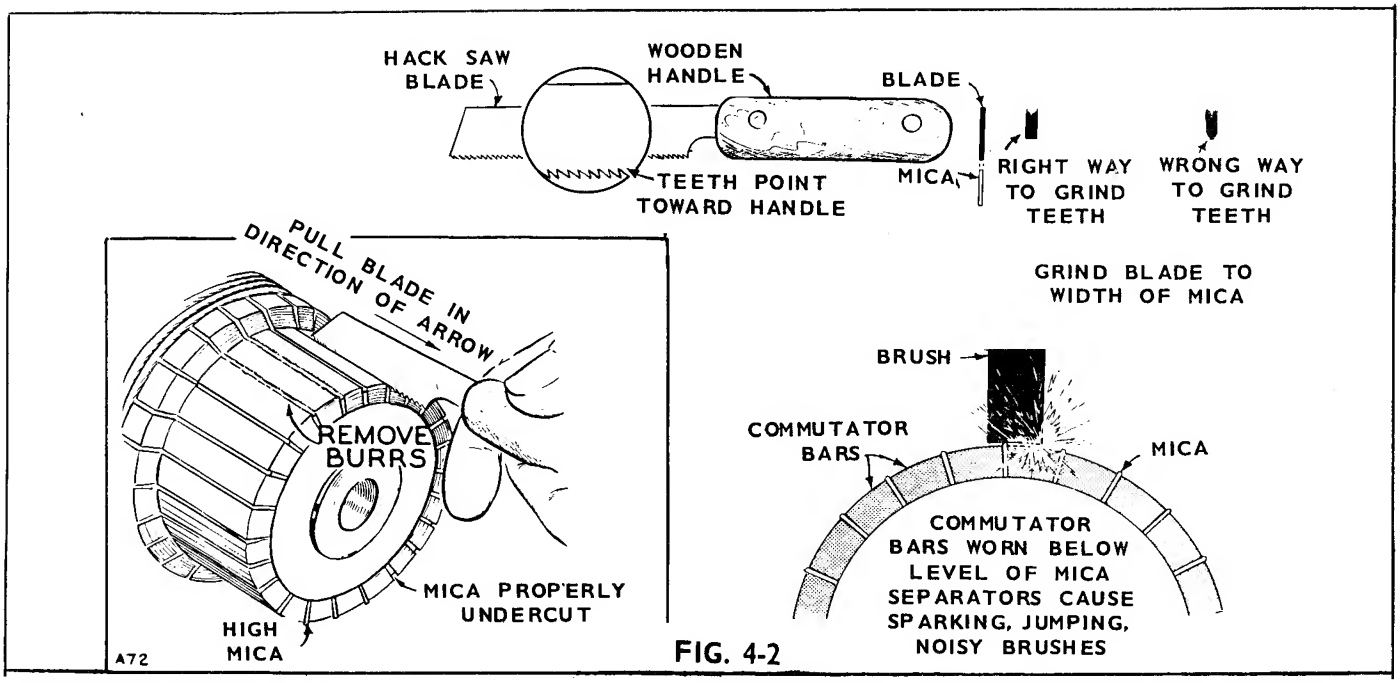


FIG. 4-2

ARMATURE GROUND TEST

To test the armature for a grounded condition, lift or remove the brushes so that none contact the commutator or collector rings. Use a continuity type test lamp set. Place one test prod on the commutator, and the other test prod on a bare, clean part of the armature shaft. The test prods must make good electrical contact. The test lamp should not glow. If the test lamp does glow, the dc winding or the commutator is grounded. To test the ac winding, place one test prod on one of the collector rings and the other test prod on the armature shaft. If the test lamp glows, the ac winding or a collector ring is grounded. Replace a grounded armature with a new one.

ARMATURE OPEN CIRCUIT TEST

The armature ac winding may be tested for an open circuit without removal of the armature. Testing the dc winding requires removal and the use of an armature growler.

To test the ac winding, be sure all brushes are lifted or removed. Use a test lamp set. Place one test prod on each of the collector rings. If the test lamp does not glow, the ac winding is open circuited. See Fig. 4-3.

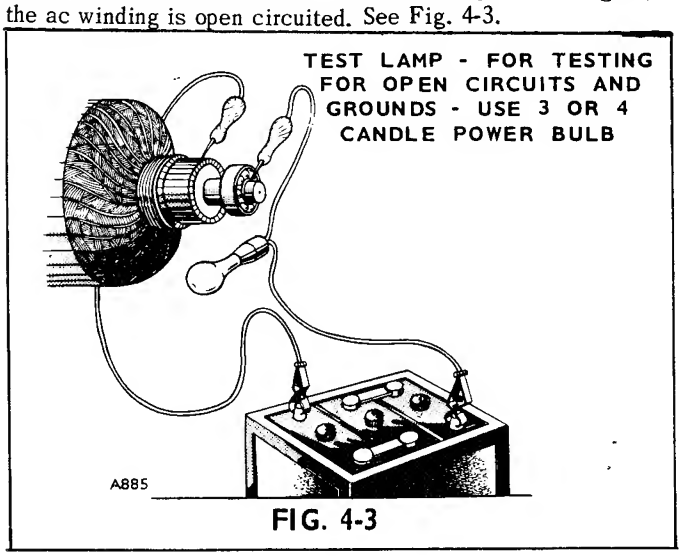


FIG. 4-3

(EXCEPTION – GENERATORS WITH 4 SLIP RINGS)

1. If the generator is a single phase model, test between the two slip rings nearest the commutator, and repeat the test between the two rings nearest the ball bearing. In each case the test lamp should glow. If the test is made between the two center rings the test lamp should not glow. If the test lamp does glow, a short circuit between the separate windings is indicated.
2. If the generator is a 3-phase, 3-wire model, the ring nearest the bearing is not connected and should be disregard.

To test the dc winding, place the armature in a growler. With the growler current on, pass a smooth steel strip across the commutator segments. Repeat all around the commutator. At some point around the commutator, a spark should occur as the strip contacts two adjacent segments. Rotate the armature slightly and repeat the test. Continue until a spark is obtained between all adjacent segments. If no spark is obtained at some point, an open circuit is indicated. **Note:**

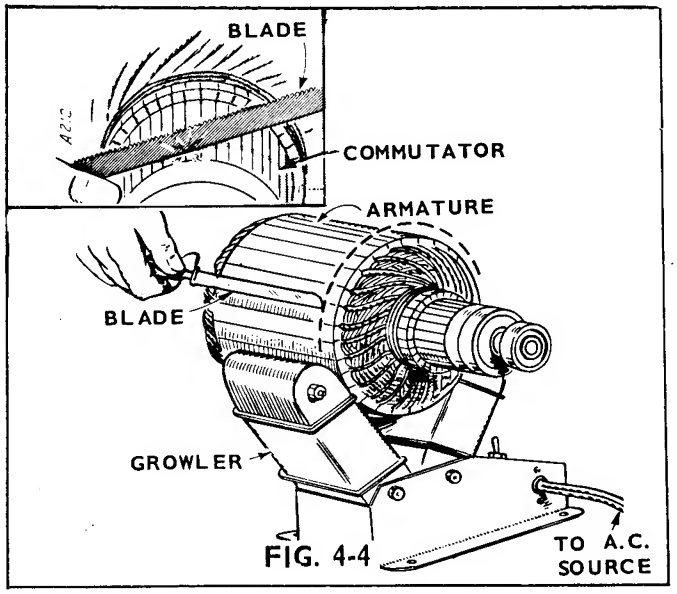


FIG. 4-4

A short circuit in the winding might prevent sparking. This condition may be indicated by the short circuit test described in the next paragraph. Replace an open circuited armature with a new one.

ARMATURE SHORT CIRCUIT TEST

To test for a short circuit, place the armature in a growler. With the growler current on, hold a steel strip about 1/2" above the armature laminations. Pass the strip back and forth over the laminations. Cover as much of the lamination area as possible. If the strip is magnetically attracted to the armature at any point, a short circuit is indicated. After testing in one position, rotate the armature slightly in the growler and repeat the test. Continue until a complete revolution of the armature in the growler has been made. Replace a short circuited armature with a new one.

TESTING FIELD WINDINGS

Use a test lamp set for all tests except a short circuit. The field coils of all ac plants are saturated shunt wound, the Remote Start plants having a series field winding in addition for cranking and battery charging purposes. When testing a field coil assembly, disconnect all of its external leads from their terminals. Tag and mark each lead to assure proper connections when reassembling.

TESTING FIELD WINDING FOR GROUNDS

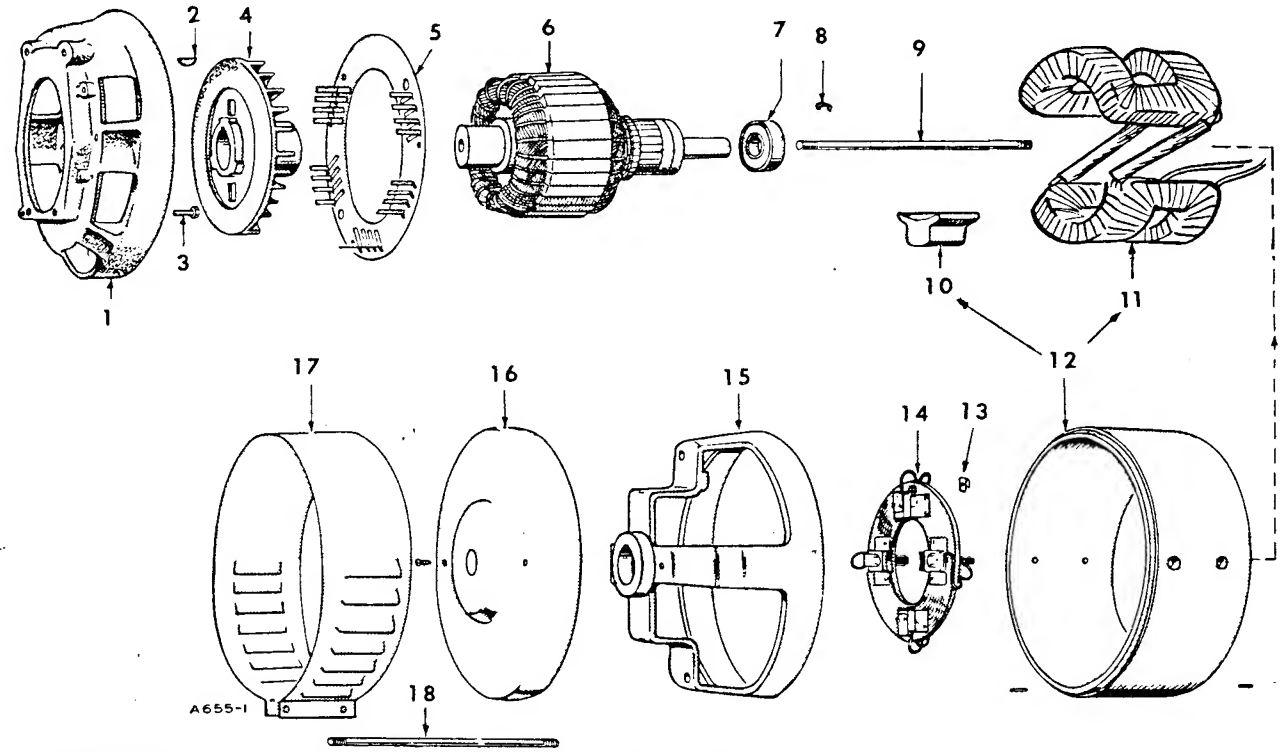
To test a coil assembly for a ground, disconnect its external leads and touch one test prod to the terminal of one of its leads and the other test prod to the generator frame. If the lamp lights, the coil assembly being tested is grounded. The ground may be in a coil, coil connection, or coil lead. Repair or replace as needed.

TESTING FIELD WINDINGS FOR OPEN CIRCUIT

To test a coil assembly for an open circuit, disconnect its external leads and touch one test prod to the terminal of one coil winding lead, and the other test prod to the other lead (or leads) of that coil winding. If the lamp does not light, the winding being tested is open. If the fault lies in a connection between coils, or in a coil lead, the connection can be repaired. If it is inside the coil, replace the entire coil assembly with a new one.

BALL BEARING

If replacement of the armature ball bearing becomes necessary, pull the bearing from the shaft with a suitable bearing puller. Be careful not to damage the armature shaft because it must remain true to serve as a turning center when refinishing the commutator or collector rings. Drive the bearing on to the shoulder on the shaft. Use a double-sealed pre-lubricated ball bearing.



1- ADAPTER
2- KEY
3- SCREW
4- BLOWER
5- PLATE
6- ARMATURE ASSEMBLY
7- BEARING
8- CLIP
9- STUD
10- SHOE
11- COIL ASSEMBLY
12- FRAME ASSEMBLY
13- CLIP
14- RIG ASSEMBLY
15- BELL
16- COVER
17- BAND
18- STUD

FIG. 4-5

GENERATOR ASSEMBLY

When assembling the generator, see that there are no nicks or dirt on the armature blower tapered surface. These conditions may cause an excessive run-out (wobble) at the bearing end. Run-out should be within .002". Assemble frame assembly and end bell. Tighten up both frame and through stud nuts. Tap end bell with hammer in the horizontal and vertical plane to make sure the bearing is not binding. Tighten the armature through stud securely. Tighten the armature through stud nut securely.

CONTROLS

If any of the control equipment fails to function properly, replace the defective part with a new part of the same kind rather than try to repair the old part. No attempt should be made to repair such parts as meters, fuses, switches, relays, or receptacles. Check all electrical connections and contacts whenever servicing control equipment.

Always disconnect the battery whenever servicing controls to avoid accidentally starting the plant. When disassembling controls, tag each lead that has to be removed and mark the connection point of the lead on the tag to assure correct connections when re-assembling.

ASSEMBLY TORQUES

Assembly torques as given here require the use of a torque wrench. These assembly torques will assure proper tightness without danger of stripping the threads. If a torque wrench is not available, you will have to estimate the degree of tightness necessary for the stud, nut or screw being installed and tighten accordingly. Be careful not to strip the threads. Check all studs, nuts and screws often. Tighten as needed to prevent them from working loose.

TORQUE SPECIFICATIONS (FT. LBS.)

Rear Bearing Plate Nuts	20-25
Connecting Rod Bolts	27-29
Oil Pump Mounting Screws	7-9
Oil Base Screws	43-48
Generator Adapter Screws	20-25
Timing Gear Cover Screws	15-20
Magneto Stator Screws	15-20
Cylinder Head Screws	29-31
Fuel Pump Mounting Screws	10-15
Flywheel Mounting Screws	35-40
Intake Manifold Screws	15-20
Exhaust Manifold Screws	15-20
Spark Plugs	25-30
Blower Housing Screws	10-15

TROUBLE-SHOOTING CHART

POSSIBLE CAUSE	REMEDY
ENGINE CRANKS TOO STIFFLY	
Too heavy oil in crankcase.	Drain. Refill with lighter oil.
Engine seized.	Disassemble and repair.
ENGINE CRANKS TOO SLOWLY WHEN CRANKED ELECTRICALLY	
Discharged or defective battery.	Recharge or replace.
Loose connections.	Tighten loose connections.
Corroded battery terminals.	Clean corroded terminals. Replace cable if necessary.
Brushes worn excessively or making poor contact.	Replace brushes or clean commutator.
Short circuit in generator or load circuit.	Repair or replace parts necessary. Disconnect load.
Dirty or corroded points in start solenoid switch.	Replace switch.
ENGINE WILL NOT START WHEN CRANKED	
Faulty ignition.	Clean, adjust, or replace breaker points, spark plugs, condenser, etc., or retime ignition.
Lack of fuel or faulty carburetion.	Refill the tank. Check the fuel system. Clean, adjust or replace parts necessary.
Clogged fuel filter.	Clean.
Cylinders flooded.	Ground spark plug cables. Crank engine with spark plugs removed.
Poor fuel.	Drain. Refill with good fuel.
Poor compression.	Tighten cylinder heads and spark plugs. If still not corrected, grind the valves. Replace the piston rings if necessary.
Wrong ignition timing.	Reset breaker points or retime ignition.

POSSIBLE CAUSE	REMEDY
ENGINE RUNS BUT VOLTAGE DOES NOT BUILD UP	
Poor brush contact.	See that brushes seat well on commutator and collector rings, are free in holders, are not worn too short, and have good spring tension.
Open circuit, short circuit, or ground in generator	Refer to the *Generator Maintenance and Repair* section.
Residual magnetism lost.	Magnetize the field.
VOLTAGE UNSTEADY BUT ENGINE NOT MISFIRING	
Speed too low.	Adjust governor to correct speed.
Poor commutation or brush contact.	Refinish commutator or undercut mica if necessary. See that brushes seat well on commutator and collector rings, are free in holders, are not worn too short, and have good spring tension.
Loose connections.	Tighten connections.
Fluctuating load.	Correct any abnormal load condition causing trouble.
GENERATOR OVERHEATING	
Short in load circuit.	Correct short circuit.
Generator overloaded.	Reduce the load.
Improper brush rig position.	Adjust.
ENGINE OVERHEATING	
Improper lubrication.	Change to proper oil.
Poor ventilation.	Provide ample ventilation at all times.
Dirty or oily cooling surfaces.	Keep the engine clean.
Retarded ignition timing.	Retime ignition.
Generator overloaded.	Reduce load.

POSSIBLE CAUSE	REMEDY
VOLTAGE DROPS UNDER HEAVY LOAD	
Engine lacks power.	See remedies under *Engine Misfires at Heavy Load*
Poor compression.	Tighten cylinder heads and spark plugs. If still not corrected, grind the valves. Replace piston rings if necessary.
Faulty carburetion.	Check the fuel system. Clean, adjust or repair as needed.
Dirty carburetor air cleaner.	Clean.
Choke partially closed.	Choke plate must be wide open at operating temperature.
Carbon in cylinders or in carburetor venturi.	Remove carbon.
Restricted exhaust line.	Clean or increase the size.
ENGINE MISFIRES AT LIGHT LOAD	
Carburetor idle jet clogged or improperly adjusted.	Clean.
Spark plug gaps too narrow.	Adjust to correct gap.
Intake air leak.	Tighten. Replace gaskets if necessary.
Faulty ignition.	Clean, adjust, or replace breaker points, spark plugs, condenser, etc., or retime ignition.
ENGINE MISFIRES AT HEAVY LOAD	
Defective spark plug.	Replace.
Faulty ignition.	Clean, adjust, or replace breaker points, spark plugs, condenser, etc., or retime ignition.
Clogged carburetor.	Clean carburetor.
Clogged fuel screen.	Clean.
Defective spark plug cable.	Replace.
ENGINE MISFIRES AT ALL LOADS	
Fouled spark plug.	Clean and adjust.
Defective or wrong spark plug.	Replace.
Leaking valves.	Grind valves.
Broken valve spring.	Replace.
Defective or improperly adjusted breaker points.	Adjust or replace breaker points.
LOW OIL PRESSURE	
Oil too light or diluted from leaking fuel pump diaphragm.	Drain, refill with proper oil. Repair or replace fuel pump.
Oil too low.	Add oil.
Oil relief valve not seating.	Remove and clean, or replace.
Badly worn bearings.	Replace.
Sludge on oil screen.	Remove and clean.
Badly worn oil pump.	Replace.
Defective oil pressure gage.	Replace.
HIGH OIL PRESSURE	
Oil too heavy.	Drain, refill with proper oil.
Clogged oil passage.	Clean all lines & passages.
Oil relief valve stuck.	Remove and clean.
Defective oil pressure gage.	Replace.
ENGINE BACKFIRES AT CARBURETOR	
Lean fuel mixture.	Clean carburetor. Adjust jets.
Clogged fuel filter.	Clean.
Air leak at intake manifold or carburetor flange.	Tighten mounting screws. Replace gaskets as necessary.
Poor fuel.	Refill with good, fresh fuel.
Spark advanced too far.	Reset breaker points or retime ignition.
Intake valve leaking.	Reseat or replace.
EXCESSIVE OIL CONSUMPTION	
LIGHT BLUE EXHAUST	
Poor compression. Usually due to worn pistons, rings, or cylinders.	Refinish cylinders. Install oversize pistons and rings.
Oil leaks from oil base or connections. This does not cause smoky exhaust.	Replace gaskets. Tighten screws and connections. Check breather valve.
Oil too light or diluted.	Drain. Refill with proper oil.
Too large bearing clearance.	Replace bearings necessary.

POSSIBLE CAUSE	REMEDY
Engine misfires.	Refer to *Engine Misfires at All Speeds.*
Faulty ignition.	Clean, adjust, or replace breaker points, spark plugs, condenser, etc., or retime the ignition.
Too much oil.	Drain excess oil.

BLACK, SMOKY EXHAUST, EXCESSIVE FUEL CONSUMPTION, FOULING OF SPARK PLUG WITH BLACK SOOT, POSSIBLE LACK OF POWER UNDER HEAVY LOAD

Fuel mixture too rich.	See that choke opens properly. Adjust jets properly. Adjust the float level.
Choke not fully open.	See that choke opens properly.
Dirty air cleaner.	Clean. Refill with proper oil.
Excessive crankcase pressure, causing excessive fuel pump pressure.	Clean breather valve.

LIGHT POUNDING KNOCK

Loose connecting rod.	Replace bearings.
Low oil supply.	Add oil. Change if necessary.
Oil badly diluted.	Drain. Refill with proper oil. Check for cause.
Low oil pressure.	See *Low Oil Pressure* for remedies.

ENGINE STOPS UNEXPECTEDLY

Empty fuel tank.	Refill.
Defective ignition system.	Check the ignition system. Repair or replace as needed. See that the *stop* button lead is not grounded.

DULL METALLIC THUD. IF NOT BAD, MAY DISAPPEAR AFTER FEW MINUTES OPERATION. IF BAD, INCREASES WITH LOAD.

Loose crankshaft bearing.	Replace unless one of the next two remedies permanently corrects the trouble.

SHARP METALLIC THUD, ESPECIALLY WHEN COLD ENGINE FIRST STARTED

Low oil supply.	Add oil.
Oil badly diluted.	Change oil. Check for cause.

PINGING SOUND WHEN ENGINE IS SUDDENLY OR HEAVILY LOADED

Carbon in cylinders.	Remove the carbon.

POSSIBLE CAUSE	REMEDIES
Spark advanced too far.	Reset breaker points or retime ignition.
Wrong spark plugs.	Install correct spark plugs.
Spark plug burned or carboned.	Clean. Install new plug if necessary.
Valves hot.	Adjust tappet clearance.
Fuel stale or low octane.	Use good, fresh fuel.
Lean fuel mixture.	Clean fuel system. Adjust carburetor jets properly.
Engine hot.	Check air circulation.

TAPPING SOUND

Valve clearance too great.	Adjust to proper clearance.
Broken valve spring.	Install new spring.

HOLLOW CLICKING SOUND WITH COOL ENGINE UNDER LOAD

Loose piston.	If noise is only slight and disappears when engine warms up, no immediate attention needed. Otherwise replace parts necessary.

VOLTAGE LOW AT FAR END OF LINE BUT NORMAL NEAR PLANT

Too small line wire used for load and distance.	Install larger or extra wires or reduce load.

MOTORS RUN TOO SLOWLY AND OVERHEAT AT FAR END OF LINE BUT OK NEAR THE PLANT

Too small line wire used for load and distance.	Install larger or extra wires or reduce load.

NOISY BRUSHES

High mica between bars of commutator.	Undercut mica.

EXCESSIVE ARCING OF BRUSHES

Rough commutator or rings.	Turn down.
Dirty commutator or rings.	Clean.
Brushes not seating properly.	Sand to a good seat or reduce load until worn in.
Open circuit in armature.	Install a new armature.
Brush rig out of position.	Line up properly.

POSSIBLE CAUSE	REMEDY
SPARK PLUG FOULED IN SHORT PERIODS OF TIME ON GASOLINE OPERATION	
Wrong spark plug gap. (Spark plug may be set at 0.018" for gaseous operation, but not changed to 0.025" when switching over to gasoline operation.)	Clean spark plugs and set at 0.025".

POSSIBLE CAUSE	REMEDY
HARD STARTING, MISSING, POPPING, ERRATIC OPERATION ON GASEOUS FUEL OPERATION	
Spark plug gap too wide. (Spark plug gap set at 0.025" for gasoline operation but not changed to 0.018" when switching over to gaseous fuel operation.)	Set spark plug gap at 0.018".

WIRING DIAGRAMS

The wiring diagrams in this section are typical and apply only to standard generating plants. Wiring diagrams for special models are available on request from the factory; send generator model, spec, and serial numbers with the request.